Volume 31 MARCH, 1947 Number 3

BULLETIN
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American Association *of* Petroleum Geologists

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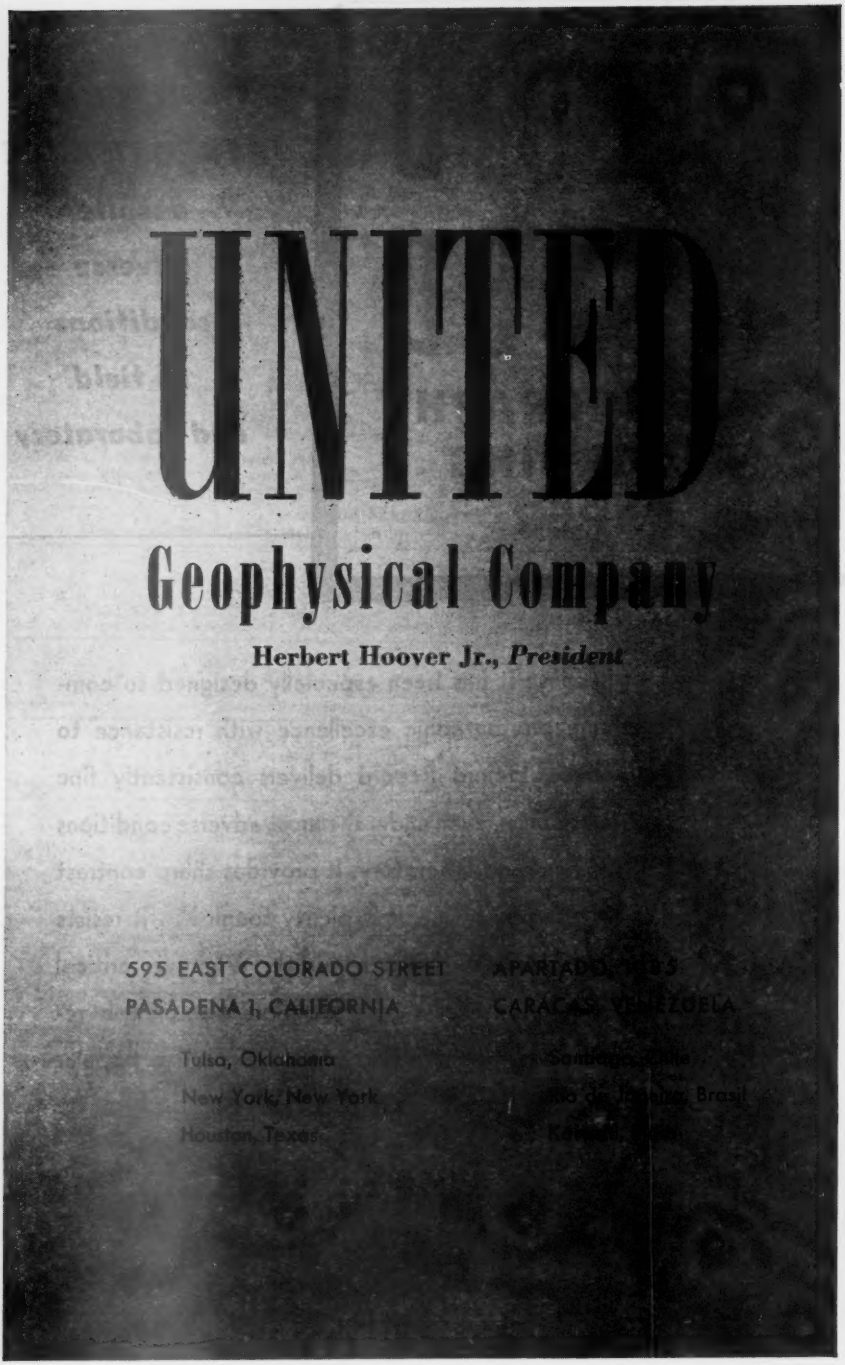
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Have dinner with me tonight?"
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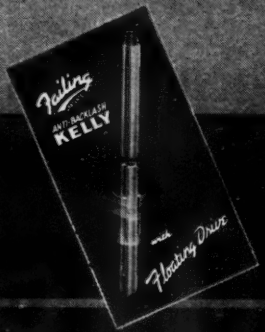

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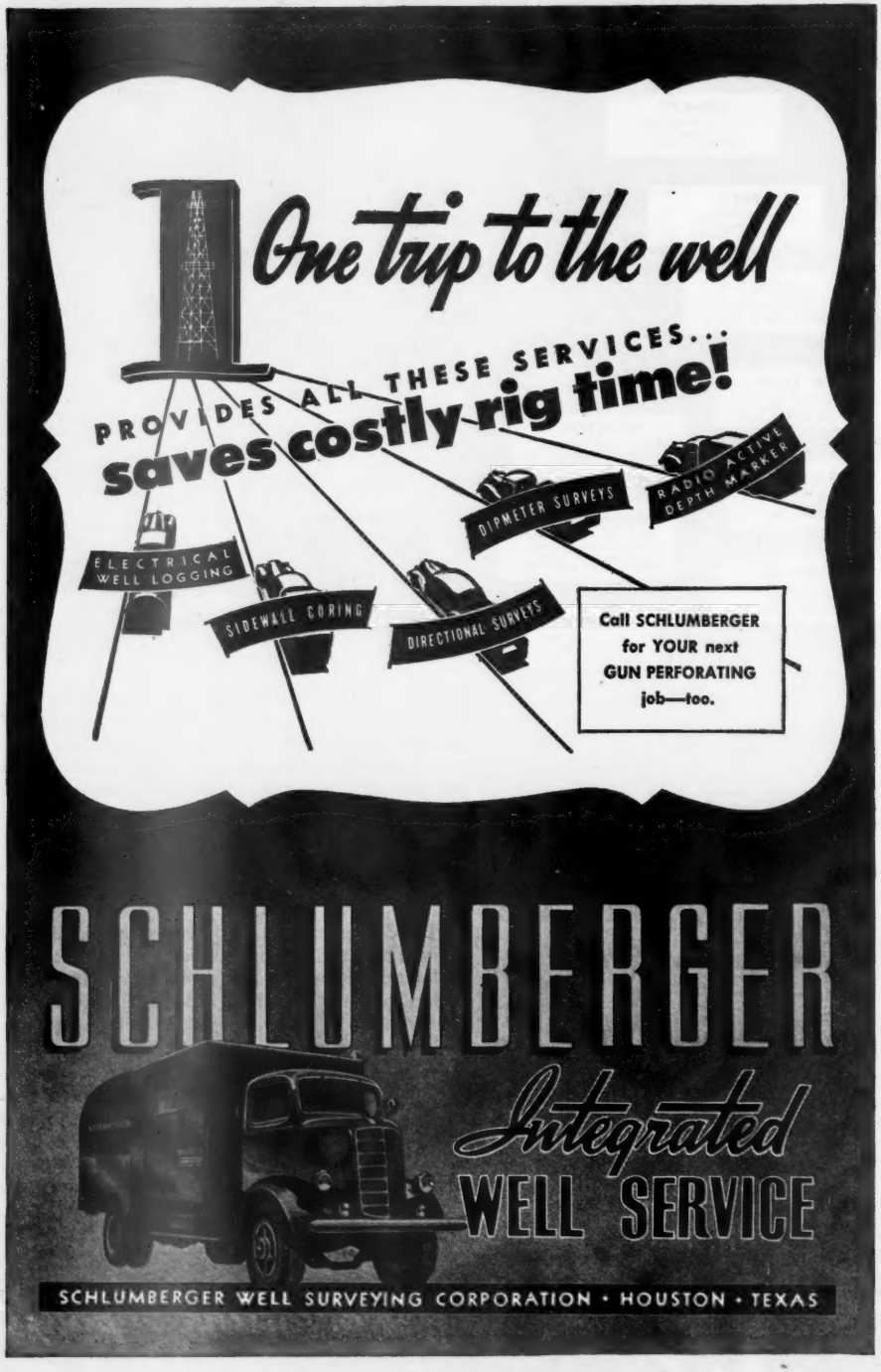
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BULLETIN
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March, 1947

DEVELOPMENT OF STRUCTURES IN BASIN AREAS OF NORTHEASTERN UNITED STATES[1]

J. R. LOCKETT[2]
Columbus, Ohio

ABSTRACT

An area comprising Illinois, Indiana, Ohio, northern Kentucky, and the western parts of Pennsylvania and West Virginia is considered as a distinct structural province. Stratigraphic evidence is cited to substantiate the premise that major positive structural features are supported by crystalline cores of pre-Cambrian mountain ranges, and that the dominant crustal movement during the entire Paleozoic era was subsidence of the intervening areas.

Importance of the weight of basins of accumulation and the results of their drag on the positive features are considered. Directions and probable extent of resultant lines of weakness in the basement complex are postulated and types of structures formed in sediments over them in Michigan, Illinois, and on the western flank of the Pittsburgh-Huntington basin are discussed. These features are shown to be primarily the results of differential subsidence, certain of the forces involved being the reverse of compressional.

The Appalachian orogenesis is considered the culminating result of an era of subsidence. Lateral effects of orogenic stress are described and evidence reviewed supporting an opinion that the province discussed was shielded from direct compression by the formation of the Pittsburgh-Huntington basin. Deformation through central Kentucky and southern Illinois is explained as the result of a westward expression of orogenic stress through greater thickness of sedimentary rock.

An experiment is described by which the general pattern of basal lines of weakness in the area were duplicated at a small scale.

The paper is intended to lay the groundwork for a new approach to the study of geologic structure in this province.

INTRODUCTION

Until recently detailed structural information in the upper Mississippi Valley was available only in isolated and unconnected areas which had been mapped by a number of agencies working independently on different types of projects. As a consequence, no comprehensive generalization of the structure could be made.

Geologists interested in this area ordinarily have assumed that minor structural features east of the Cincinnati arch are the results of lateral pressure caused by the Appalachian folding and that those in Indiana and Illinois were caused by or formed coincident with the uplifting of the Cincinnati, Kankakee, and La

[1] Read before the Association at Chicago, April 3, 1946. Manuscript received, November 25, 1946.

[2] Department of geology, Ohio State University. Independent project.

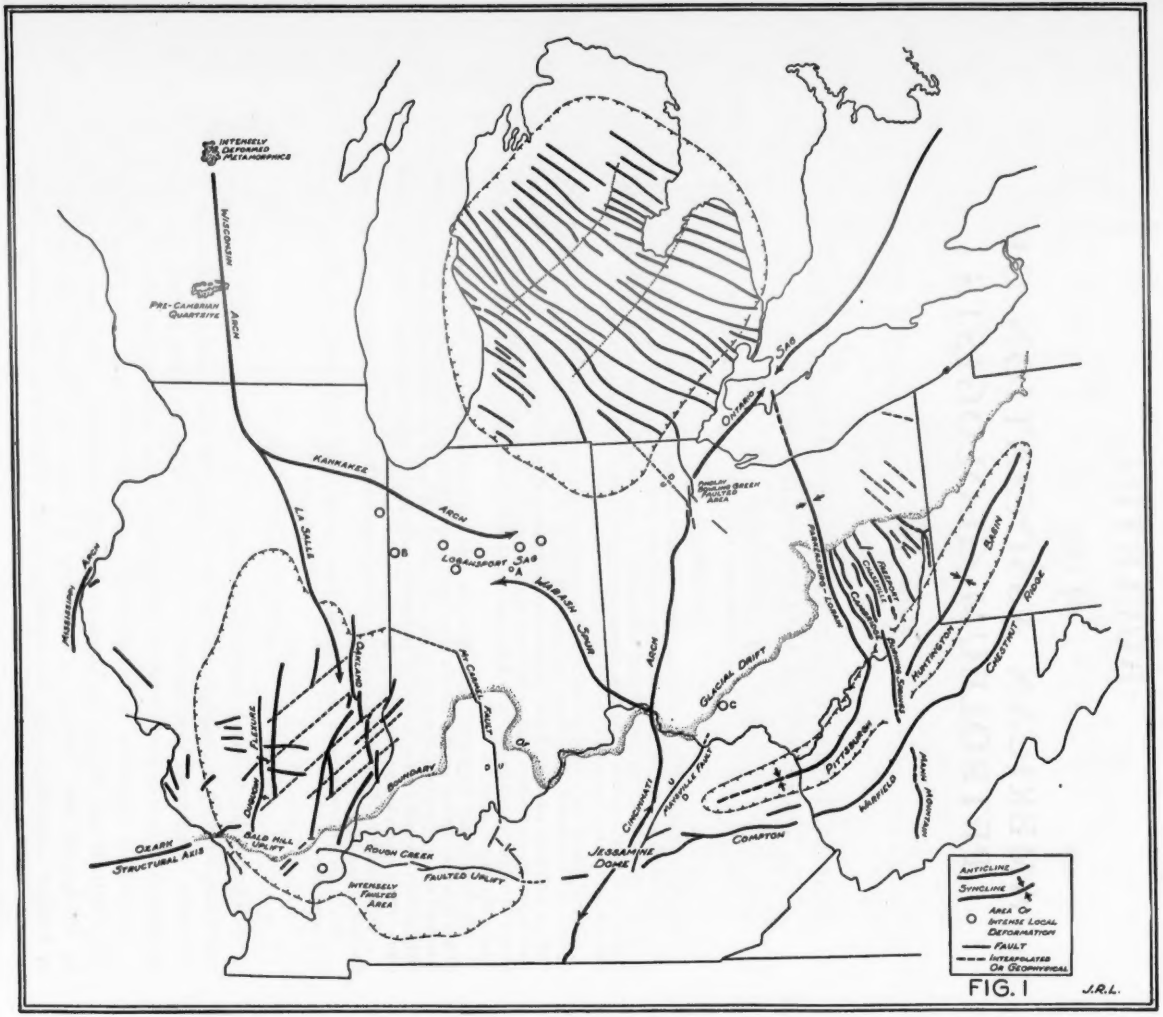


FIG. 1.—Structural trends in basin areas of northeastern United States. Michigan basin after R. B. Newcombe, 1935, and Virgil R. D. Kirkham, 1937. Illinois basin after J. Marvin Weller and Alfred H. Bell, 1937, George V. Cohee and Charles W. Carter, 1940, and Darsie A. Green, 1940.

Salle anticlines. The age of these latter features has remained a matter of conjecture.

As surface and subsurface mapping progressed, certain structural trends and stratigraphic relations became apparent which tend to disprove many of these opinions. Information now available suggests that an area comprising Ohio, the southern peninsula of Michigan, Indiana, Illinois, and northern Kentucky should be considered as a distinct structural province within which the major and minor features are directly related but not, however, as the result of the uplift of either. There is no evidence to indicate that direct lateral pressure caused by the Appalachian orogeny appreciably influenced structure west of the Pittsburgh-Huntington basin.

GENERAL STRUCTURE

Within the province outlined, the dominant positive areas are the branching northern extension of the Nashville dome, known as the Cincinnati arch with its Wabash spur, and the branching southern extension of the Wisconsin arch, known as the La Salle and Kankakee anticlines. The principal negative areas are the Illinois, Michigan, and Pittsburgh-Huntington basins. The trends or locations of these major features together with the axes of certain related minor structures are generalized in the map (Fig. 1).

For an understanding of the sequence of geologic events and the types of movement which caused or influenced the development of these structures, we are principally dependent on the study of stratigraphy. Certain very local exposures of highly deformed metamorphics in Wisconsin and their relation to the overlying sedimentaries when linked with subsurface data from Ohio and Ontario form the key to an understanding of the structure of this area in very early pre-Cambrian time.

The basal complex under southern Wisconsin forms a broad, southward-plunging arch, with a maximum relief of 1,500 feet, which branches and extends into the Illinois basin and across northwestern Indiana as two distinct folds in the sedimentaries. As already noted, these are called the La Salle and Kankakee anticlines.

Weidman[3] has discussed an extensive mountain system in Wisconsin which was practically base leveled before the Paleozoic era. A study of certain exposures in central Wisconsin, particularly an area of intensely deformed Huronian and Laurentian rocks in Marathon County and another of crumpled pre-Cambrian quartzite exposed along the axis of the arch in Sauk County, caused him to describe these mountains as comparable in structure and magnitude with the Alps, the Alleghenies, or the Rockies. The north-south axis of the domed erosional surface of complexly deformed metamorphics, the core of this ancient mountain range, indicates that the trend of the mountains was also north-south. The continuations

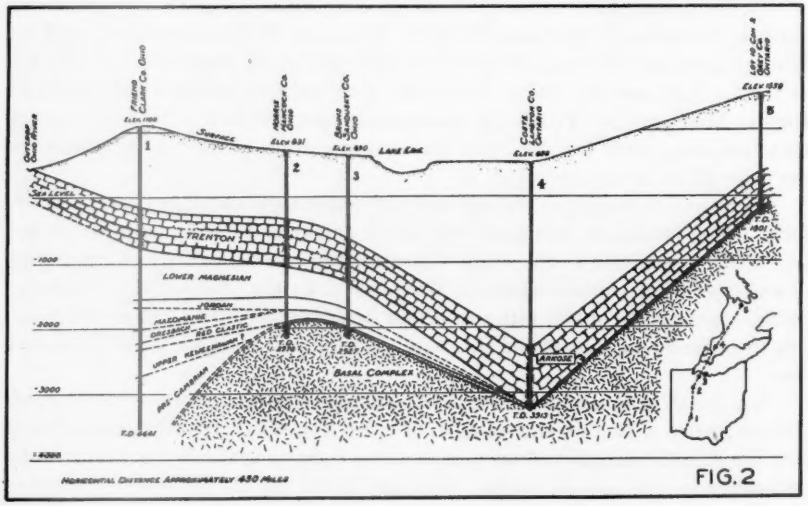
[3] Samuel Weidman, "Geology of North Central Wisconsin," *Wisconsin Geol. Survey Bull.* 1 (1907).

Kirkham, 1937. Illinois basin after J. Marvin Weller and Alfred H. Bell, 1937, George V. Cohee and Charles W. Carter, 1940, and Darsie A. Green, 1940.

of the same axes into southern Illinois and across central Indiana is the only remaining indication of their original extent.

By late Cambrian time these mountains were sufficiently reduced to be overlapped by the St. Croixan series in southern Wisconsin and there are relatively few breaks in the sequence of later sediments which covered the area. As these beds are practically horizontal, we may infer that the locality has not been appreciably disturbed.

The basal complex under the Cincinnati arch has been penetrated in six holes in northwestern Ohio and two in Ontario. From a depth of 1,940 feet below sea-level in the Findlay field (No. 2, Fig. 2) it drops approximately 2,000 feet into southern Ontario from where it rises toward the northeast into the Canadian shield. Below this arch in southwestern Ohio the crystalline surface plunges at a



rapid but undetermined rate toward the south. A hole located near the axis in Clark County (No. 1, Fig. 2), 85 miles south of the Findlay well, which was drilled to the total depth of 4,647 feet, or 3,522 feet below sea-level, did not reach crystalline rocks but penetrated 807 feet of sedimentary beds considered by Mrs. Wasson[4] as probably pre-Cambrian in age.

Wherever samples have been available from the vicinity of the arch, the basement rocks were found to have a gneissoid character. As far east as southern Delaware County, in central Ohio, pieces show a definite alignment of minerals, indicating that the material has been subjected to intense compression. The presence

[4] Isabel B. Wasson, "Sub-Trenton Formations in Ohio," *Jour. Geol.*, Vol. 40 (November-December, 1932).

of garnet in samples of crystalline rock from the Findlay well[5] (No. 2, Fig. 2) and in an arkose reported in the Clark County well[6] (No. 1, Fig. 2), although not conclusive proof, is strongly suggestive of metamorphic rock in the former and a nearby metamorphosed source for the latter.

The relation of the sediments to the basal complex along the trend of the Cincinnati arch from Ohio River to the Canadian shield is shown in Figure 2. It may be noted that in the vicinity of Lake St. Clair in southern Ontario, at the lowest point along this axis, the Trenton limestone is the first sediment above the arkose mantle of the crystallines. From the southward thickening of the intervening sediments and their relation to both the basal complex and the base of the Trenton, it becomes apparent that the beds in the northern part of this area were not deposited in their present attitudes.

When an interpolation of this section is made with the top of the Trenton horizontal, as in Figure 3, the succession of sediments may be seen very nearly ap-

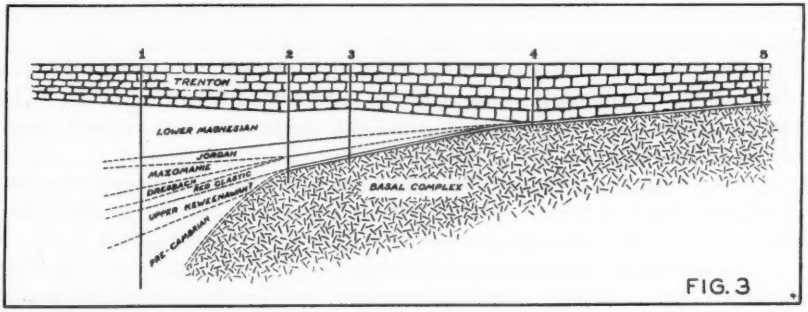


FIG. 3

proaching their original positions with the Trenton and sub-Trenton beds successively overlapping a southward-plunging crystalline surface along the crest of the Cincinnati arch in the same manner that early sediments overlapped metamorphics along the trend of the Wisconsin arch. This interpolation also indicates that both the crystalline and sedimentary beds have dropped approximately 2,000 feet in southern Ontario since Trenton time.

The presence of the Trenton limestone as the first real sedimentary bed above the basal complex in southern Ontario is significant evidence that this area remained above sea-level until well along in Ordovician time, whereas the remains of the Wisconsin mountains began to submerge during late Cambrian. From this we may safely infer that, until Trenton time, southern Ontario had consistently

[5] D. D. Condit, "Deep Wells at Findlay, Ohio," *Amer. Jour. Sci.*, Ser. 4, Vol. 36 (1913), p. 127.

[6] Samples from 3,330 to 3,823 feet were re-examined for heavy minerals at the request of the writer by Miss Lou Williams of the Pure Oil Company in June, 1938. A mineral "suggestive of garnet" was reported between 3,330 and 3,335 feet and a "questionable fragment" of pink garnet between 3,818 and 3,823 feet.

remained at a greater elevation than Wisconsin. This inference, substantiated by our knowledge of the gneissoid character of the basal rock under the northern extension of the Cincinnati arch, leads to the conclusion that a very early mountain chain also extended from Canada through western Ohio and on south, the reflection of which remains in the sedimentary rocks as the Cincinnati arch. The fact that this axis is connected with the Wisconsin-La Salle axis through the Wabash spur and the Kankakee arch in the form of the letter N suggests that these early mountains were all one system. The relatively short interim between their base leveling in Wisconsin and Ontario precludes the possibility of any great difference in age, particularly in view of the probable difference of elevation in parts of such a system.

Pirtle[7] has suggested that the La Salle and Kankakee arches are southern extensions of the pre-Cambrian deformation in Wisconsin and considers the major unconformities separating the principal divisions of the sedimentary rocks to indicate intermittent movement along the old axis during all Paleozoic time. However, Newcombe[8] has noted seven pronounced sedimentary breaks within the Michigan basin and suggests that other minor interruptions occurred.

All contacts which are known to be definitely unconformable in the Michigan basin are also unconformable along the La Salle-Wisconsin axis and that of the Cincinnati arch. We may, therefore, consider the periods of emergence represented to have been regional in extent.

Certain authors have maintained that these major positive features are compressional folds which were formed during comparatively recent geologic time but few have cited stratigraphic evidence to support their contentions.

Both Newcombe and Pirtle have quoted Stockdale,[9] the former that the Mississippian "rocks" thicken toward the arch in Indiana and the latter that the Mississisippian "beds" thicken in that direction, from which it is inferred that a Mississippian depositional basin was subsequently elevated. Although the Mississippian system as a whole thins away from the arch, the decrease in thickness is caused by the successive disappearance of the top members at a post-Mississippian erosion surface which dipped toward the basin more sharply than the inclination of the beds. This system was beveled in the same manner east of the Cincinnati arch.

Extensive studies by Clark[10] prove that certain beds of Mississippian age differ sufficiently in both lithology and fauna in exposures northeast and southwest of the Kankakee-Wabash axis to indicate the presence of an intervening barrier at the time of their deposition.

[7] George W. Pirtle, "Michigan Structural Basin and Its Relation to Surrounding Areas," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 16, No. 2 (February, 1932).

[8] R. B. Newcombe, "Structure and Accumulation in the Michigan Basin and Its Relation to the Cincinnati Arch," *Problems of Petroleum Geology*, Amer. Assoc. Petrol. Geol. (1934).

[9] Paris B. Stockdale, department of geology, University of Tennessee, Knoxville, Tennessee. Personal communications quoted.

[10] Charles K. Clark, Pure Oil Company, Saginaw, Michigan. Personal communication.

DOWNWARP OF POSITIVE FEATURES

In the opinion of the writer sufficient evidence is available to warrant the assumption that the dominant positive structural features in the area under discussion are underlain by the cores of pre-Cambrian mountains for which reason they have remained more or less positive and that the principal movement during the entire Paleozoic era was the continued subsidence of the basins into which the original mass of the mountains had been deposited as sediments.

This premise leads to speculation on what effect such widespread and continued subsidence would have had on the intervening areas.

A realization of the true proportions of these basins is essential for an understanding of the stresses created by their subsidence. Neither the Michigan nor Illinois basins should be considered as particularly abysmal features. During Paleozoic time a much more profound syncline than either lay between the Cincinnati arch and the vicinity of the present Atlantic coast in which at least 5 to 6 miles of sediments had accumulated by the close of the Paleozoic era.

The relation of the overlapping sediments to the basal complex previously discussed and shown in Figures 2 and 3 is conclusive evidence that the crest of the Cincinnati arch has dropped approximately 2,000 feet in southern Ontario since the Trenton was deposited. In determining the cause of this movement, the primary factor to be considered is the great weight of sediments which had accumulated by Ordovician time in the Appalachian basin. The downward pull of this weight, combined with that from the smaller Michigan basin and exerted where the two were separated only by the old positive arch, eventually would have become sufficient to start this downwarp directly across the old axis. Such movement would have been continued by the increasing accumulation of sediments in both basins.

In the same manner a similar downwarp, known as the Logansport sag, was formed where the Michigan and Illinois basins are nearest together.

The Kankakee-Wabash axis may be generalized as a continuous feature connecting the Wisconsin and Cincinnati arches. However, when mapped in detail, the Kankakee axis turns toward the Michigan basin and that of the Wabash spur inclines an equal distance toward the Illinois basin. Mapped on the Trenton the low between the two axes is 500 feet below the junction of the Cincinnati arch and Wabash spur and 2,000 feet below the junction of the Kankakee and Wisconsin arches.

A well drilled in this depression near Kokomo, Indiana (A, Fig. 1), is reported by Logan[11] to have reached the Bayfield sandstone of Keweenawan age at a depth of 3,945 feet. This record could not be used by Mrs. Wasson[12] in correlating the sub-Trenton beds west from Ohio but if it is correct only as to major sub-

[11] W. N. Logan, "The Geology of the Deep Wells in Indiana," *Indiana Dept. Conservation Pub. 55* (1926), p. 256.

[12] Isabel B. Wasson, "Sub-Trenton Formations in Ohio," *Jour. Geol.*, Vol. 40 (November-December, 1932).

divisions, the earliest beds which overlap the basal complex under the Wisconsin arch are at least 1,400 feet lower in the Logansport sag. Therefore any individual bed in the lowest part of this downwarp is something over 1,000 feet below a plane connecting its elevation at each end of the Kankakee-Wabash trend. This figure represents, as nearly as can be determined from available data, the probable minimum extent of the downward movement between the Michigan and Illinois basins.

CRYPTOVOLCANISM AND FAULTING

The division of the original Kankakee-Wabash axis with the bilateral shift toward each basin is an indication of the extent of tensional stress which accompanied the downwarp of this arch under the weight of accumulated sediments on either side. The entire Kankakee-Wabash trend was subjected to stresses which were the reverse of compressional and, as a result, a very interesting type of deformation took place. Within the intervening space between the present axes of the two arches, in a more or less east-west trend through the Logansport sag, there are at least seven areas of very intense local deformation. In one such structure near Kentland (B, Fig. 1), described by Bucher[13] as cryptovolcanic, there is approximately 1,500 feet of vertical displacement within 3 miles.

A downward, lateral pull sufficient to cause at least 1,000 feet of subsidence along the crest of an old positive area would also cause a sustained horizontal tension in the beds effected. Consequently, a critical isostatic condition would eventually result. Wherever this tension became sufficient to compensate for the difference between the weight of solid rock and the pressure of magma from below, there would be a possibility of cryptovolcanic action characterized by such vertical displacement. This explanation is offered by the writer for these occurrences of intense local deformation across north-central Indiana.

The presence of 20 feet of diabase at a depth of 3,965 feet within the Bayfield sandstone, reported by Logan in the Kokomo well (A, Fig. 1), if correct, suggests the possibility of intrusive action resulting from such local disturbance.

The conception that the dominant positive features have separated subsiding basins of accumulation within this province since the inception of the basins must be modified by the foregoing evidence that the positive areas also sank between the basins. Such an understanding makes possible an investigation of the directions and extent of lines of weakness which would develop in the basal complex under the stresses incident to such movement and to speculation as to the types of structures which would be formed in the sedimentary rocks above them.

The eastern edge of the Illinois basin in southwestern Indiana is marked by the Mt. Carmel fault with a basinward downthrow of approximately 200 feet. This is exposed in Mississippian beds. If the subsidence of this relatively shallow basin caused faulting in Mississippian time or later, it seems quite probable that along the eastern side of the Cincinnati arch, where the drag of a much deeper

[13] Walter A. Bucher, "Cryptovolcanic Structures in the United States," *International Geologic Congress, Washington, 1933, Rept. 16*, p. 1072.

basin was exerted on a positive feature, faulting should have occurred at a much earlier time. The Maysville fault which affected Ordovician beds in northwestern Kentucky lies in a proper relation to the axis of the Cincinnati arch to bear out this supposition. This fault has not been traced, as yet, into the overlying Silurian beds in southwestern Ohio, a fact which has led to speculation on the possible presence of buried deep-seated faults parallel with the Cincinnati arch in central and possibly eastern Ohio.

In this connection, it is interesting to note that in Adams County, Ohio, directly in line with the trend of the Maysville fault, a typical cryptovolcanic structure has been mapped by Bucher[14] (C, Fig. 1). Within a circular area, 4 miles in diameter, beds have been lifted vertically an average of 350 feet and a maximum of 950 feet. The youngest beds involved in this deformation are basal Mississippian.

Many explanations have been offered for this phenomenal upheaval in a part of the country which otherwise has been little disturbed. However, to the author's knowledge, no one has pointed out that the load of sediments, which accumulated in the great basin on the east by Mississippian time, would have caused a horizontal tension along the east side of the Cincinnati arch at least equal to that exerted in north-central Indiana where a similar type of local deformation has been noted.

In eastern Ohio certain areas where surface beds are deformed, together with some well defined subsurface features and accumulations of petroleum and natural gas in a number of sands, occur in northeast-southwest alignments. Extensive northeast-southwest faults, with the downthrow on the southeast, have been identified by seismic work in southeastern Ohio.[15] These circumstances require explanation because the axes of most well defined structural features in that part of the state have northwest-southeast trends.

The northeast-southwest alignment of productive areas and indications of deformation, with the geophysical evidence of faulting, suggests the probable presence of very deep-seated step faults through central and eastern Ohio parallel with the Cincinnati arch. Such faults could have been entirely covered by the normal succession of series up to and including basal Permian. Buried faulting, caused by the drag of the Appalachian basin, is an interesting possibility which remains to be investigated by much deeper drilling than has been attempted heretofore. However, for reasons discussed later, it appears that if such faults or lines of weakness exist in eastern Ohio they are of minor importance.

FORMATION OF LINES OF WEAKNESS EAST AND SOUTH OF ONTARIO SAG

Any material which is capable of both folding and fracturing will develop cracks through a downwarp due to the tension development. As the subsidence

[14] Walter A. Bucher, *op. cit.*, p. 1061.

[15] L. E. Randall, Geophysical Company, Inc., Parkersburg, West Virginia. Personal communication. Details held confidential.

in Ontario continued after the deposition of the Trenton limestone, a syncline was formed which extended from the center of the downwarp far toward the southeast and lines of weakness or cracks developed in the basement rocks which continued an undeterminable distance into the old Paleozoic basin. The known structural features which have been formed over these lines of weakness in eastern Ohio are shown in Figure 1. Minor structural trends in the northeast corner of the state which recently have been identified by geophysical methods are aligned from N. 45° W. to almost east-west, a fact which suggests that these lines of weakness radiate from the center of the sag.

The possibility of movement along such zones after early Ordovician time no doubt relieved the tension along the east side of the Cincinnati arch. This may account for the fact that the Maysville fault, which disturbed Ordovician rocks in Kentucky, has not been traced northeast into Ohio. Likewise, this lack of a sustained tension in the zone where such lines of weakness approach the axis of the arch accounts for the absence of further cryptovolcanic disturbance north of Adams County.

Another result of the subsidence in southern Ontario was a definite pattern of northwest-southeast faulting which crossed the axis of the Cincinnati arch in northwestern Ohio, along the south hinge line of the downwarp. Accumulations of petroleum and natural gas in the Trenton limestone crossed the crest of the arch only in zones of leaching and secondary mineralization associated with these faults and the drag zone on the north. Trenton production from the entire Lima-Indiana field has been from zones of secondary porosity, in many places of honeycomb texture, where tensional fracturing permitted percolation. As yet, no actual displacement has been plotted across the Wabash spur on the hinge line of the Logansport sag. However, it is crossed by a definite alignment of low anticlinal structures, perpendicular to the axis, through producing areas in Randolph and Jay counties, Indiana. Producing fields only cross this arch on the downwarped side where the Trenton limestone has been subjected to tensional stress. The highest parts of both anticlines, near their junction, as yet are barren.

Step faulting probably resulted from differential subsidence along zones of weakness in the basal rocks east of the Cincinnati arch and depositional structures of some magnitude may have been formed in the accumulating sediments. However, for a proper understanding of the types of folds which now mark these ancient cracks in the crystalline floor, the effect of later deformation in the east should be studied.

APPALACHIAN OROGENESIS

Evidence has been presented to show that the major crustal movement during Paleozoic time in the area under discussion was the uninterrupted subsidence of the basins of accumulation, and, as such movement became more pronounced, even the intervening pre-Cambrian positive elements were affected. The eventual result of such widespread and continued sinking of the earth's crust would be relief in the way of a compensating upward movement.

If sand is fed onto wet paper stretched over paste in approximately the proportions of the sediments in the three basins, the paper will eventually break beneath the greatest load and paste will rise through the sand. A similar relief marked the end of Paleozoic time. Probably the greatest mountain building period in the history of the eastern half of the continent followed an entire era of subsidence.

Structure of the remaining cores of the vast range which rose from the depths of the great Appalachian basin indicates that, unless their elevation was accompanied by very severe erosion, they attained heights equal to the present Himalayas.

Needless to say, the lateral effects of such deformation was widespread. However, toward the northwest, the effect of direct thrust was not as far-reaching as many geologists have supposed. About one-third of the distance between the mountains and the crest of the Cincinnati arch, the sedimentary formations were sufficiently thin to permit a buttressing effect in the basal complex. The primary result of the lateral pressure, therefore, was buckling which formed a secondary syncline with a northeast-southwest trend, parallel with the mountains, through western Pennsylvania and western West Virginia. This feature is known as the Pittsburgh-Huntington basin. East of the axis of this trough, structure was complicated by types of failure governed by the relative competence of the beds but, in general, broad, open folds parallel the mountains.[16] However, west of this axis, structural trends have not been found paralleling those on the east.

Willis[17] has demonstrated that an actively forming fold absorbs the lateral pressure which causes it. The effective stress was expended in the formation of this syncline. Consequently, the area west of the Pittsburgh-Huntington axis was shielded from deformation by direct lateral pressure.

However, certain of the basal lines of weakness which had previously developed through the Ontario sag extended a sufficient distance into the old basin of accumulation to entirely cross the Pittsburgh-Huntington basin into the zone of orogenic stress. Structure above such lines was considerably accented by deformational forces which followed these pre-existent cracks but which were in no way compressional. As a result of such action, the Burning Springs arch, the sharpest fold in the structural province under discussion, crosses the Pittsburgh-Huntington basin in a direction slightly west of north. Deformation along this same trend may be traced into southern West Virginia as the Mann Mountain anticline.

In eastern Ohio a number of more or less parallel, northwest-southeast anticlinal trends which branch from the Burning Springs have been mapped in the surface beds as far as the southern boundary of the glacial drift and continued northwest by subsurface mapping in the direction of the Ontario sag. Because of

[16] Paul H. Price, "The Appalachian Structural Front," *Jour. Geol.*, Vol. 39, No. 1 (January-February, 1931).

[17] Bailey Willis and Robin Willis, *Geologic Structures*, 2d ed. (1929).

the manner in which they were formed, and their tangential directions, these folds decrease in magnitude in their northern extension. Where possible to determine the planes of their axes, they have been found to be vertical.

The northwest-southeast syncline through eastern Ohio, which resulted from the Ontario downwarp, has been previously mentioned. If this feature extended a greater distance southeast in Paleozoic time, its southern extension was completely obliterated by the formation of the Pittsburgh-Huntington basin. The junction of the axes of the two troughs now forms an angle of approximately 60°. This very prominent feature was first mapped by Panyity[18] in 1920 as the "Marietta-Coshocton" syncline. It was later recognized by Stout[19] as extending entirely across Ohio from Parkersburg, West Virginia, to Lorain on Lake Erie, and has since been called the "Parkersburg-Lorain" syncline. Inasmuch as it connects the Pittsburgh-Huntington basin with the Michigan basin across the Cincinnati arch, it could very properly be termed the Appalachian-Michigan syncline.

WESTWARD EXPRESSION OF OROGENIC FORCE

In Figure 2 it may be noted that crystalline rocks beneath the Cincinnati arch in northwestern Ohio form an arch or ridge which plunges toward the south at a rate which would permit a possible thickness of sedimentary rocks in north-central Kentucky somewhat in excess of 10,000 feet. This is a greater thickness of sedimentary beds than remains along the east flank where the buttressing effect of this old positive area counteracted the westward orogenic forces. As we have no evidence that the rate of erosion since Permian time has differed greatly in southeastern Ohio and central Kentucky, it is probable that at the time of the Appalachian folding the thickness of sediments in these areas were in approximately the same ratio as those which remain at present.

It may be noted in Figure 1 that the axis of the Pittsburgh-Huntington basin parallels the mountains through western Pennsylvania and northern West Virginia but turns much more toward the west in western West Virginia. In this westward extension the trough disappears against the Cincinnati arch in eastern Kentucky. A consistent uplift paralleling the axis of this syncline to the east and south can be traced as the Chestnut Ridge-Warfield axis in western Pennsylvania and central West Virginia and as the Compton anticline in eastern Kentucky. However, this uplift crosses the Cincinnati arch in the Jessamine dome and continues west forming the southern boundary of the present Illinois basin as the Rough Creek and Bald Hill uplifts.[20]

The westward result of the intense orogenic forces involved in the Appalachian deformation was the formation of the Pittsburgh-Huntington basin where these forces were applied in direct compression against the buried crystalline

[18] L. S. Panyity, mapped as private work. Personal communication.

[19] Wilber Stout, former State geologist of Ohio, unpublished report.

[20] James H. Gardner, "A Stratigraphic Disturbance through the Ohio Valley, Running from the Appalachian Plateau in Pennsylvania, to the Ozark Mountains in Missouri," *Bull. Geol. Soc. America*, Vol. 26 (1915), pp. 477–83.

ridge in northwestern Ohio. As had been noted previously, this crystalline ridge plunged rapidly southward into northern Kentucky where it was covered by many thousand feet of sedimentary beds. The Appalachian orogenesis subjected this great thickness of sediments to direct deformational stress from the east which progressed unimpeded until the old Ozark positive crystalline mass was encountered. The result was the series of connected uplifts approximately 600 miles long. Types of failure along the trend of this deformation varied somewhat with the character of the rocks affected. The uplift was accompanied by intense faulting, particularly in the less competent younger rocks east and west of the Cincinnati arch.

MICHIGAN BASIN

The development of structures within the Michigan basin has been more simple than those described heretofore, and, as a consequence, their trends are less complex.

During the Paleozoic era, three sides of the periphery of this basin remained more or less stationary while the southeast end continued to subside in the Ontario sag Under these conditions a system of fractures or lines of weakness developed in the basal complex through the unsupported end parallel with the northeast and southwest sides which remained positive. The increasing load of sediments caused differential subsidence along these lines of weakness with greater accumulation on the basinward side. This probably amounted to step faulting toward the central axis in the basal complex and the deeper sediments.

Kirkham[21] postulated a system of northwest-southeast faults in the basement similar to those exposed in crystalline rocks on the north and supposed that a movement of magma from under that region permitted it to subside. He then showed by a series of figures how asymmetric depositional folds with practically vertical axes would develop as sediments accumulated over such areas of differential subsidence. More logical reasons may be advanced for the occurrence of a basin of accumulation between two ancient elevations and for the pattern of basal failure. However, his explanation of the formation of such depositional structures is basically sound and could account for folds of considerable magnitude.

A number of writers have visualized rather cataclysmic occurrences in order to account for these structural trends. Great torsional twists, compression of the basin from northeast to southwest by orogenic force, and buttressing against the Cincinnati arch have been described.

In considering such statements it is helpful to visualize the actual proportions of the basin. Mapped on the top of the Trenton limestone, the east-west distance across its center between sea-level contours is 400 miles. The depth of the Trenton in the center of the basin is probably about 9,000 feet. The ratio of depth to width

[21] Virgil R. D. Kirkham, "Possibility of Future Oil Production in Michigan." Read before the Association at Wichita, March 21, 1935. Revised form with map, *Oil and Gas Jour.* (May 13, 1937), p. 45. Figures as yet unpublished.

is, therefore, roughly 1:260. As an example of these proportions, it may be said that a baseball diamond with the pitcher's mound 8 inches above the bases, is as typically anticlinal as the Michigan basin is synclinal.

In view of the results of the experiments described by Willis, previously mentioned, it seems highly improbable that deformational stress could have been transmitted through this basin even if it had been appreciably compressed. Orogenic force implies mountain-building activity. If such forces deformed Pennsylvania beds, they would have been generated by the formation of mountains at least as young as the Appalachians. Some topographic evidence should indicate the existence of post-Pennsylvanian mountains. Anticlinal folds with a relief of approximately 1,000 feet, such as the Howell anticline, when considered in their true relation to the extent of the basin, seem hardly of sufficient proportion to warrant the assumption of crumpling orogenic force to account for their formation.

It may be demonstrated that tensional cracks, developed in any friable material permitted to sink in the proportions this basin has sunk, are primary and simple. The extraordinarily parallel pattern of the Michigan structural trends conform to primary fractures thus produced. The basic lines of weakness under the basin may, therefore, be considered as the results of simple subsidence.

Tests recently drilled on well defined anticlines in the deeper part of the basin have encountered salt in the Salina group varying in thickness from 1,500 to almost 2,000 feet.[22] Flow in such a mass would take place toward zones of less resistance which, in Michigan, would be toward the zones of differential subsidence above the basal faults. As a result structural relief above the Salina would have been greatly increased. This condition is indicated by such information as is available at present.[23] The importance of movement within great masses of salt as a contributing factor in the development of structure in Michigan, and elsewhere in the area under discussion, has not been generally recognized.

The series of Devonian and Silurian limestones and dolomites, known in Ohio as the "Big lime," thickens from 600 feet in the central part of the state to 2,000 feet in Columbiana County at the eastern edge. The greatest individual increase in this interval is that of the Salina group. The Oriskany sandstone produces both petroleum and natural gas from typical stratigraphic traps along the western edge of the sand body in the east-central part of the state. The only place in Ohio east of these fields where structural relief is sufficient to bring the Oriskany out of the water as a producing sand is in Columbiana County above the greatest thickness yet plotted for the "Big lime" and consequently for the Salina.

The Oriskany also produces gas in several fields in southern New York and northern Pennsylvania. This accumulation is controlled by structures with relief

[22] Jed B. Maebius, Gulf Refining Company, Saginaw, Michigan, "The Results of Drilling of a Deep Test Near Bay City, Michigan." Read before the Association at Denver, April 24, 1942.

[23] George D. Lindberg, Sun Oil Company, Toledo, Ohio. Unpublished cross sections through southeastern Michigan and northwestern Ohio.

ranging from several hundred to several thousand feet, certain of which are greatly complicated by faulting. These anticlines occur over the greatest thickness of Salina in that area and below them the Medina has been found to dip normally toward the south.[24]

In view of this information it seems highly probable that the extraordinary relief which increases along structural trends toward the center of the Michigan basin is the result of movement within underlying bodies of salt.

Folds with relief comparable with those in Michigan are not found in the same proximity to the Ontario sag along lines of weakness extending southeast into Ohio. This sag occupied the entire southeast end of the Michigan basin, hence the principal directions of deposition were across the forming folds. Heavier accumulation on the downward side would have accelerated differential subsidence and, eventually, developed considerable structural relief. However, the sag was a very minor feature in the periphery of the great eastern Paleozoic basin, and lines of weakness developed by its formation radiated from the center. Directions of deposition more nearly paralleled their trends, hence differential subsidence caused by unequal loads of sediments was not an important factor in that area. Moreover, the Salina group is relatively thin in north-central Ohio, a fact which would preclude the possibility of structural relief being accented by movement of salt.

It would seem that if such definite basal cracks were developed through the Ontario downwarp similar fractures should have been formed through the Logansport sag. As yet we have little evidence of such zones of weakness northeast of the Kankakee-Wabash axis. In the paper previously mentioned, Kirkham described northeast-southwest faults through the center of the Michigan basin on either side of Saginaw Bay with an intervening garben. These are shown in Figure 1 by dotted lines. It is quite possible that some types of structural expression cross the basin in that direction as a reflection of the downwarp toward the southwest. As such zones would have extended in the direction of deposition, for the reasons previously stated, structural development over them would have been of minor consequence. However, their intersections with the northwest-southeast axes may have an important bearing on the repetition of local highs along the principal structural trends. Greater flexibility in such areas would have permitted a more ready flow of salt.

ILLINOIS BASIN

The Illinois basin presents a greater complexity of structural trends than any of the areas yet discussed. This is primarily because of the shape of the basin and the types of deformation which influenced development of local structures.

Mapped on the Devonian shale, the ratio of depth to width is approximately

[24] Charles E. Fralich and James F. Pepper, Belmont Quadrangle Drilling Corporation, Bradford, Pennsylvania. Unpublished manuscript.

1:250. For the purpose of this discussion it may be considered, therefore, as similar in proportion to the Michigan basin.

This area of subsidence was formed around the southern extension of the old Wisconsin arch, shown on Figure 1 as the La Salle-Oakland anticlinal trend. The location of the Mt. Carmel fault along the eastern edge of the basin has been mentioned. About an equal distance west of the central anticlinal axis the north-south trend of the Duquoin flexure may be considered as a hinge line east of which the rate of basinward dip is greatly increased.

During Paleozoic time, this basin extended a considerable distance farther south. The relative proportion of this southern extension, as determined by outcrops, is shown as its outline in Figure 1.

In a basin with such a shape, lines of weakness parallel with a more or less positive side or the axis of the positive central area could have developed in almost any direction. The possible formation of depositional structures with considerable relief where such lines crossed the direction of deposition was brought out in the discussion of the Michigan basin.

The east-west trend of deformation which crossed the southern end of the basin at the time of the Appalachian folding has also been mentioned. Orogenic stress of great intensity was exerted through the great thickness of relatively incompetent Mississippian and Pennsylvanian formations deposited in the southern part of the old basin. As a consequence, the resultant uplift was characterized by complex and pronounced faulting. As this force was dissipated against the old Ozark uplift, tangential stresses were created which further complicated the structure of the area. Certain northeast-southwest structural trends have been mapped which may be the results of such deflected stress or pre-existent zones of weakness may have been accented in that manner.

Mylius[25] found that closures along the La Salle axis were related to a series of northeast-southwest crossfolds. More recently Cohee and Carter[26] have connected corresponding irregularities in producing fields which they plotted in a series of six parallel northeast-southwest trends (dashed lines, Fig. 1).

Probability that certain basal lines of weakness developed through the Logansport sag has been previously mentioned. It should be pointed out that the trends first recognized by Mylius and, later, plotted by Cohee and Carter extend in the direction of this sag. Such zones, along which the crystalline floor is more flexible, should be present in both the Illinois and Michigan basins. As yet their significance has not been generally recognized. They may be marked by only minor structural relief but where they intersect more pronounced features, structural development of great importance may have occurred.

[25] L. A. Mylius, "Oil and Gas Development and Possibilities in East Central Illinois," *Illinois Geol. Survey Bull. 54* (1927), pp. 167–68.

[26] George V. Cohee and Charles Carter, "Structural Trends in the Illinois Basin," *Trans. Illinois State Acad. Sci.*, Vol. 32, No. 2 (1940), pp. 168–69.

FIG. 4.—Tension cracks developed in film of plaster on sheet of black wax which has sunk into depressions, relative proportions of which approximate those of Paleozoic basins discussed.

SUPPORTING EXPERIMENTAL EVIDENCE

The trends of lines of weakness in the crystalline floor under the entire area considered in this discussion have been duplicated in a rather crude manner in a simple experiment. Plaster was allowed to solidify in a pan. Depressions were then scraped out to duplicate as nearly as possible the depth, shape and locations of the three basins during Paleozoic time. A flat sheet of black wax coated with white plaster was then laid over the plaster surface in the pan. This was then subjected to a sufficient weight of warm sand to cause the plaster-coated wax to sink into the depressions. Figure 4 is a photograph of the tensional cracks thus developed in the coat of plaster. The supported parts have been darkened. A glass tube had let air out of the depressions from the lower right corner. Unrelated cracks in that part have been painted out. Bearing in mind that this was an attempt to duplicated conditions before the Appalachian folding, it is possible to see a striking similarity between these cracks and the trends of lines of weakness in the crystalline floor which have been described in this discussion.

A system of cracks diverge to the lower right from the sag in the Cincinnati arch and some were formed parallel with it. The parallel system is well developed in the upper depression and the Mt. Carmel fault is duplicated along the right side of the one on the lower left which represents the Illinois basin. Other cracks in that depression paralleled the edges. Due probably to the crudity of the equipment and the very slight depression in the part representing the Logansport sag at this scale, the plaster remained suspended and no cracks developed through that part perpendicular to the axis.

CONCLUSION

We have no reason to assume that structural trends in this area are much more complex than the pattern developed by this simple experiment when the modification caused by the uplift of Appalachian mountains is kept in mind.

With such an understanding of the history of this structural province, the direction of the known trends may be explained. These principles should be of considerable value in projecting trends through irregularities discovered by local subsurface or geophysical work in the greater part of the area which is too flat for satisfactory surface mapping or is covered by glacial drift.

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STRATIGRAPHY AND STRUCTURE OF TRAVERSE GROUP IN AFTON-ONAWAY AREA, MICHIGAN[1]

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East Lansing, Michigan, and San Antonio, Texas

ABSTRACT

The stratigraphy of the middle Devonian Traverse group of parts of Presque Isle and Cheboygan counties is described. The scattered outcrops are correlated in part with the better known section in northeastern Michigan, which includes southeastern Presque Isle and eastern Alpena County, and in part with northwestern Michigan which includes Emmett and Charlevoix counties. Reliance is placed principally on correlation of faunal zones for those relatively thick alternating limestone and shale subdivisions, such as the Genshaw and Gravel Point formations of the Traverse group. Sharp lithologic breaks between other subdivisions which, between their upper and lower boundaries, are characterized by uniformity in composition and texture, also are useful in correlation. The discrepancy in total thickness between the Traverse of the described area and the Traverse sections of the east and west is emphasized, and diastrophism suggested as the cause. Three new stratigraphic names, Koehler limestone, Gorbut (a member of the Gravel Point), and Beebe School formation, are defined and described. The writers use their stratigraphic divisions in making a structural contour map of the area, which shows two anticlines, one north of Onaway, and a second, west of Afton.

INTRODUCTION

The Afton-Onaway area is in the north-central part of the Lower Peninsula of Michigan (Fig. 1.), and includes an area of about 50 square miles in Cheboygan and west-central Presque Isle counties. This paper describes the formations of the Traverse group of Middle Devonian age which crop out in this area, and the structural relationships determined from their distribution.

Most of the field work was done in the summer of 1941 with financial assistance furnished by the Geological Survey Division of the Conservation Department of Michigan. Outcrops were located with respect to section corners. Those along the highways were located by speedometer readings, and all others by pace-and-compass traverses. Elevations were carried from all exposures by hand level and stadia rod traverses to bench marks established by the United States Coast and Geodetic Survey, or to secondary control points established by precise levelling by F. G. Dewell.

STRATIGRAPHY

The classification of the rocks of the Afton-Onaway area involves correlation with the better known sections bordering on both the Lake Huron and Lake

[1] Parts of this paper are condensed from a thesis entitled "Stratigraphy and Paleontology of the Genshaw and Ferron Point Formations in Cheboygan and Western Presque Isle Counties, Michigan," submitted by the junior writer to the Graduate School of Michigan State College in partial fulfilment of the requirements for the degree, Master of Science, in June, 1942. Manuscript received, August 13, 1946. The writers are indebted to many former students, as well as to members of the staff of the department of geology at Michigan State College, for important contributions. Relevant information on faunal studies was also obtained from G. A. Cooper, of the United States National Museum, and from G. M. Ehlers, of the department of geology of the University of Michigan. Able assistance in the field was given by W. J. Anderson and H. K. Martin. Thanks are due to Norio Mitsuoka for the drafting of maps and sections.

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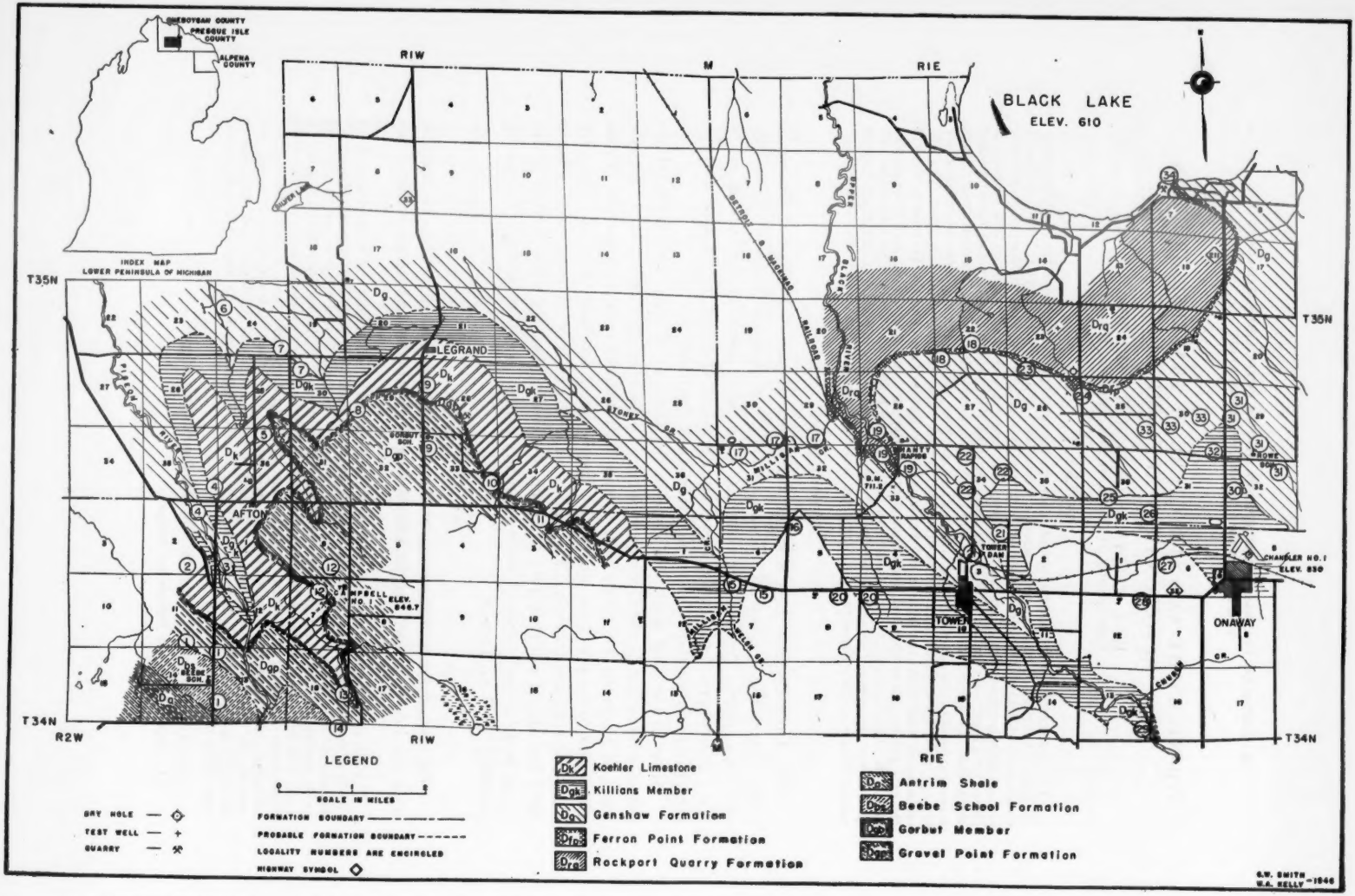
CHEBOYGAN COUNTY
PRESQUE ISLE COUNTY
ALPENA COUNTY
INDEX MAP
LOWER PENINSULA OF MICHIGAN
R1W
M
R1E
BLACK LAKE
ELEV. 610
T35N
T34N
R2W
LEGRAND
AFTON
CAMPBELL NO. 1 ELEV. 646.7
TOWER DAM
TOWER
ONAWAY
CHANDLER NO. 1 ELEV. 830
LEGEND
SCALE IN MILES
DRY HOLE
TEST WELL
QUARRY
FORMATION BOUNDARY
PROBABLE FORMATION BOUNDARY
LOCALITY NUMBERS ARE ENCIRCLED
HIGHWAY SYMBOL
Dk Koehler Limestone
Dgk Killians Member
Dg Genshaw Formation
Dfp Ferron Point Formation
Drq Rockport Quarry Formation
Da Antrim Shale
Dbs Beebe School Formation
Dgp Gorbut Member
Dgp Gravel Point Formation
G.W. SMITH
W.A. KELLY -1946

Michigan areas. With the exception of the Bell shale, which is not exposed in the Afton-Onaway area, the lower half of the Traverse group is readily correlated with the outcrops north of Alpena on the Lake Huron side of the Lower Peninsula. The upper part of the Afton-Onaway section resembles part of the section between Petoskey and Charlevoix on Little Traverse Bay.

The correlation of published names applied by various authors to the stratigraphic units of the northern part of the Lower Peninsula is given in Figure 2.

The highest beds of both the Lake Huron shore vicinity and Lake Michigan shore vicinity sections either are not represented, or are so imperfectly represented that they can not be recognized with certainty. The estimated total thickness of the Traverse group south of Afton is considerably less than that for either the sections near Lake Huron or Lake Michigan. Because Afton is no farther from the center of the Michigan synclinorial basin than are Alpena and Petoskey, the estimated thickness is less than the expected thickness, and suggests different environmental conditions.

The Traverse of the Afton-Onaway area includes the Bell shale, the Rockport Quarry limestone, the Ferron Point shale, and the Genshaw formation, the Koehler limestone (new name), the Gravel Point formation, and the Beebe School formation (new name). The Genshaw formation includes the Killians member and the Gravel Point formation includes the Gorbut member (new name).

DISTRIBUTION AND CLASSIFICATION

Bell shale.—The Bell shale does not crop out within the area considered. It has been recognized, however, in samples from many water wells and from test wells which have been drilled for structural information. The writers have been able to study samples obtained from two wells in Cheboygan County: the Lenoran Petroleum Company's well in Sec. 23, T. 35 N., R. 1 E., and the Frances Oil Company's Campbell No. 1 in Sec. 7, T. 35 N., R. 1 W. In both these wells the Bell shale is easily recognized, with the basal part characterized by an abundance of crinoid columnals.

Rockport Quarry limestone.—The type locality for this formation is in the Rockport Quarry, northeast Presque Isle County (Warthin and Cooper, 1943, p. 580). In that locality two distinct facies, a lower dark, irregularly bedded, fossiliferous, argillaceous limestone section 28 feet thick, and an upper light gray, evenly bedded, stylolitic, dense, sparingly fossiliferous, relatively pure limestone 12 feet thick, are represented. In the abandoned Onaway Limestone Company's quarry on the south shore of Black Lake, the formation has a minimum thickness of 50 feet. The lower 5 feet of the section is represented by the black shaly facies and is exposed along the lake shore on the west edge of the quarry. The upper 45 feet is represented by evenly bedded, stylolitic, dense, sub-lithographic limestone and is exposed on the east wall of the quarry. Excepting these quantitative differences, the sections near Lake Huron and Onaway resemble each other.

The black argillaceous facies does not crop out in the Afton-Onaway area,

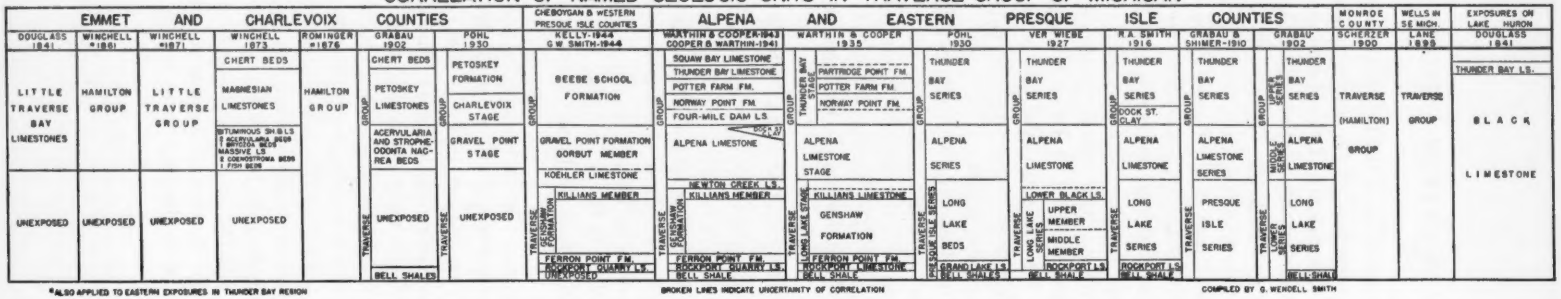

FIG. 2.—Correlation of named geologic units in Traverse group of Michigan.

although it is exposed about 8 miles northeast of Onaway at Ocqueoc Falls, and also 1½ miles east of the falls in the bed and banks of the Little Ocqueoc River. It is apparently represented in the Onaway well (Smith, R. A., 1914, p 215). The dense facies is not represented at the Ocqueoc Falls and Little Ocqueoc localities, but the dense facies is the only facies exposed at Shanty Rapids on Black River, and on the lower part of Milligan Creek, southwest of Black Lake. The dense facies is also recognized in samples from the two wells in Cheboygan County, previously mentioned.

Ferron Point formation.—The type locality for the Ferron Point formation is in northeastern Alpena County (Fig. 1), and has been described by Warthin and Cooper (1935, p. 526; 1943, pp. 581–82). Outcrops of this formation are uncommon in the Afton-Onaway area. The formation has been recognized in the abandoned quarry on the south side of Black Lake, in a ditch near the N. ¼ corner of Sec. 34 of the same township, in excavations in Secs. 25 and 26, about 2 miles south of Black Lake, and near the mouth of Milligan Creek. Its presence in the western part of the Afton-Onaway area, is known from drill records and well samples.

The thickest section of the Ferron Point was measured along the south shore of Black Lake near the Cheboygan-Presque Isle county line. It is 9 feet thick, and provides a marked contrast in thickness to the 35 foot section of the type locality. At Black Lake the Ferron Point formation is apparently conformable with both the underlying Rockport Quarry limestone and the overlying Genshaw limestone. It consists of very soft, light gray, calcareous shale interbedded with thin lenses of dense limestone. It is very fossiliferous, and contains several diagnostic fossils. The fossils limited to the Ferron Point are *Chonetes fragilis*, *C.* aff. *coronatus*, *Mucrospirifer* sp. II,[4] and *Pentamerella* cf. *pavilionensis*.

Other characteristic fossils in the Ferron Point are *Aulopora* sp. aff. *A. serpens*, *Pterinea* cf. *flabellum*, and several species of *Tentaculites*. Studies by Henry Faul (unpublished report) show that the common species of *Hexagonaria* (*Prismatophyllum*) found in this formation are distinct from species found in the higher formations.

The Ferron Point is recognized in drill cuttings from the Frances Oil Company's Campbell No. 1 in Cheboygan County. The determination was made on the basis of its lithologic character and its stratigraphic relationship to the underlying Rockport Quarry limestone.

Genshaw formation.—The type localities for the Genshaw formation as amended by Warthin and Cooper (1943, p. 583), are in the area between the city of Alpena, Michigan, and the northeastern part of Alpena County. An interterupted belt of outcrops of this formation extends northwesterly from Alpena County through Presque Isle to the central part of Cheboygan County. In the

[4] It is not within the scope of this paper to describe the fauna of the Traverse of the Afton-Onaway area. A monographic study of Traverse Brachiopoda by G. A. Cooper of the United States National Museum, is being made. The numerals attached to the generic names imply only that the junior writer recognizes the occurrence of more than one species of a single genus, and that many of these have different stratigraphic ranges.

Afton-Onaway area the outcrops of the Genshaw are more common than those of other subdivisions of the Traverse, and for this reason the Genshaw receives more detailed discussion than do other formations of the Traverse. The greatest break in the outcrop belt is between the Michigan meridian and a north-south line drawn through the village of LeGrand (Fig. 1). A large esker and associated glacial debris occupy this area and obscure the bed rock. The westernmost outcrops of the Genshaw formation is along the Pigeon River in the western part of the Afton-Onaway area.

The Genshaw, as redefined, has a thickness of 116 feet in Alpena County. In the western part of the Afton-Onaway area, drill cuttings from the Campbell well No. 1, NE. ¼, Sec. 7, T. 34 N., R. 1 W., show 150 feet of limestone referable to the Genshaw. Thus the Genshaw is thicker in the western area than it is in the east. The discrepancy is greater than the difference between 150 and 116, since the writers limit the Genshaw of Cheboygan County to the top of the youngest member recognized with certainty, namely, the Killians. Overlying formations include some beds which may be upper Genshaw in age.

A correlation of the Genshaw formation outside of Michigan is now possible because of the work of Cooper and Warthin (1935, pp. 376–77; 1941, pp. 259, 260; 1942; p. 885). These authors believe that the Genshaw and Ferron Point are to be correlated with the Skaneateles formation of the Hamilton group of New York.

In the Afton-Onaway area the top of the Genshaw is represented by the Killians black limestone member. At the type locality the Killians is overlain by higher members of the Genshaw, and by the Newton Creek limestone (Warthin and Cooper, 1935, p. 526; 1943, p. 584), but in the vicinity of Afton, the Koehler limestone is above the Killians, although separated from it by an interval which includes a buff limestone referable, possibly, to the Newton Creek.

In establishing the equivalence of rather widely separated outcrops of the Genshaw formation in the Afton-Onaway area, it was necessary to make a detailed study of the contained fauna. Repetition of lithologic types in the Genshaw below the Killians member made correlation by lithology hazardous. The lower part of the Genshaw is composed of alternations of dark gray shaly limestone and calcareous shale, with some black coloring, and there are no beds lithologically constant and unique. The Killians member of the Genshaw, in contrast, is characteristically a black shaly limestone and readily recognized. Furthermore, the Killians fossils usually exhibit a distinctive mode of preservation in which their surfaces have been penetrated by a black bituminous material, which is in strong contrast to the nearly white calcium carbonate preserving the interior of the skeletons.

A study of several hundred fossil specimens, chiefly brachiopods, by the junior writer, resulted in the identification of 10 genera and 25 species of brachiopods, and several species each of stromatoporoids, corals, cephalopods, and trilobites.

There are six faunal zones recognized in the Genshaw formation in this area. The first zone is in limestone in the lower 10 feet of the Genshaw, and contains

species of *Chonetes* related to *C. fragilis*, in association with *Pentamerella?* sp. aff. *P. dubia*, both of which also occur in the Ferron Point shales.

The next higher faunal zone in the Genshaw is the lower *Pentamerella* zone, characterized by *Pentamerella* sp. IV. This species occurs only in the lower 20 feet of the formation.

Ranging from 25 to 70 feet above the base of the Genshaw is the *Clathrodictyon-Pentamerella* zone, containing abundant specimens of the brachiopod *Pentamerella?* sp. I, and the stromatoporoid *Clathrodictyon* cf. *retiforme*. Large coralla of a new species of *Hexagonaria* (Faul, 1942) also occur abundantly in this zone.

The *Cyrtina* zone overlies the *Clathrodictyon-Pentamerella* zone, and at its highest occurrence the upper limit is about 100 feet above the base of the Genshaw. This zone is about 6 feet thick, and contains great numbers of *Cyrtina* represented by at least three species.

The transitional zone from the gray sub-Killians Genshaw into the black Killians member is characterized by an abundance of *Mucrospirifer* sp. I and *Chonetes* sp. aff. *C. fragilis*. Fish plates of an undetermined genus and pygidia of the trilobite *Proetus* are also abundant in the transitional zone.

Mucrospirifer sp. I ranges upward into the Killians member, but there it is associated with a large species of a breviconic cephalopod, provisionally referred to *Gomphoceras*. The lower part of the Killians contains *Chonetes* sp. aff. *C. fragilis*. This represents a recurrence, since the species is also found in the lower 10 feet of the Genshaw. The black limestone and shaly limestone of the Killians are commonly separated by a concealed interval from the light gray to buff, sparsely fossiliferous, sub-lithographic limestones of the overlying Koehler formation.

Newton Creek limestone.—There are relatively few exposures of beds stratigraphically higher than the Killians member of the Afton-Onaway area. Some of these may belong to the Newton Creek formation.

The type locality for this formation is the quarry of the Michigan Alkali Company at Alpena (Cooper and Warthin, 1941, p. 260). In that locality it includes 25 feet of dark brown, crystalline limestone, which is separated from the underlying Killians member by gray or light brown limestone of the upper Genshaw (Warthin and Cooper, 1943, p. 584).

Warthin and Cooper recognize the Newton Creek in the Afton area (Warthin and Cooper, 1943, p. 584), but it is certainly a small part of the Afton section. The authors tentatively refer beds of buff to light brown dolomitic limestone which outcrop in Sec. 29, T. 35 N., R. 1 W., to this formation. In the Frances Oil Company's Campbell No. 1 there are no brown beds between the black Killians and the gray Koehler limestone. The stratigraphic interval, however, between the top of the Killians and the top of the Koehler in this well is 50 feet as compared with the 75 foot interval between the top of the Killians and the top of the Newton Creek in the Alpena area (Warthin and Cooper, 1943, pp. 583–84). The total thickness of the interval between the Ferron Point and the

top of the Koehler formation is 200 feet, which is essentially equivalent to the interval between the Ferron Point and top of the Newton Creek in the Alpena area. It is possible that the upper Genshaw and Newton Creek of the Alpena area are represented by different facies in the Afton area.

Koehler limestone.—There are relatively few exposures of beds stratigraphically higher than the Killians member in the Afton-Onaway area.

The Koehler limestone is defined to include gray, bedded, dense limestones of sub-lithographic texture, which are known to overlie the Killians black limestone member, and underlie, unconformably, the Gravel Point crystalline and shaly limestone strata. The type locality is in the abandoned quarry of the Campbell Stone Company, one mile north of the village of Afton, Koehler Township, Cheboygan County. Other exposures include the sections in the small quarries known as the LeGrand Quarry, the Marvin or Little Campbell Quarry, and the Sorenson Quarry, as well as a few imperfect exposures along road cuts and valley slopes.

The most eastern exposure is in Sec. 5, T. 34 N., R. 1 E., west of Tower, but float derived from the Koehler has been observed one mile west of Onaway along the road between Secs. 31 and 36, T. 35 N., Rs. 1 and 2. The following section was measured along the north face of the Campbell Stone Company Quarry.

	Thickness Feet	Inches
Overlying formation—Gravel Point		
Bed 8—Clay seam with spherical and ellipsoidal chert concretions. Surfaces of concretions rough and pitted. Fracture surfaces reveal impressions of cubic and tetragonal crystals	1	
Bed 7—Light gray limestone with connected solution cavities near top. Cup corals provisionally assigned to genus *Heterophrentis* common in lower half. Separated from bed below by thin layer of platy black shale	2	
Bed 6—Light bluish gray, blocky, stylolitic, dense sub-lithographic limestone with irregular calcite fillings. Rock has conchoidal fracture and metallic ring	5	8
Bed 5—Black, platy, hard shale	0	4
Bed 4—Dark gray dense limestone, with thin intercalation of calcareous shale at base	0	8
Bed 3—Light gray, blocky, dense, sub-lithographic limestone	1	
Bed 2—Concealed	4	
Bed 1—Light gray, thinly bedded, dense limestone forming base of quarry		

North of the quarry and on the lower slope of the hill, a pit exposes limestone of the Koehler facies. There is a concealed vertical interval of 30 feet between the bottom of the pit and the highest exposed strata of the Killians black limestone member. The evidence suggests that the Koehler formation has a thickness of 30 to 40 feet. This is substantiated by the drill cuttings from the Campbell well No. 1, Sec. 7, T. 34 N., R. 1 W., south of Afton.

The upper part of the Koehler is exposed at two localities: the Afton Quarry and the LeGrand Quarry, the latter near the middle of Sec. 28, T. 35 N., R. 1 W. Only a few feet of the beds near the upper contact are missing in the Marvin and Sorenson quarries. The former is in Sec. 7, and the latter in Sec. 11, T. 34 N., R. 1 W.

There is a prominent break at the clay seam, bed No. 8, in the Campbell

Stone Quarry and the overlying beds are assigned to the Gravel Point. The clay seam may be traced almost continuously around the walls of the quarry, but the detailed characters of the beds immediately beneath the clay seam differ from each other. In the section measured along the north side of the quarry, bed 7 underlies the clay seam. At a distance of 800 feet the section on the south side of the quarry shows a 4-foot bed of gray fragmental limestone intercalated between the clay seam and bed 7. The 4-foot bed contains an agglomeration of small heads of *Hexagonaria* and *Favosites* in addition to fenestellids and crinoid columnals.

In the Marvin Quarry the highest bed of the Koehler is a dense sub-lithographic limestone which contains a relatively large number of gastropod molds.

No fossiliferous strata were observed in the exposures of the Koehler formation in the LeGrand Quarry. The beds above the Koehler are, in contrast, persistent, and no stratigraphic break is apparent. The irregular contact between the tops of the Koehler and the lower Gravel Point, suggest that a part of the Koehler was eroded prior to the deposition of the Gravel Point.

The assignment of the Koehler to a formation older than the Gravel Point rather than to the Charlevoix, as indicated by Pohl (1930, Pl. I, Col. 6 and 10) is made for several reasons. Although both formations are characterized by dense semi-lithographic and stylolitic limestone, and gastropods have been found in each, little weight is assigned to these criteria. Limestone of lithographic character is comparatively common in Michigan. Such limestone occurs in the Rockport Quarry formation near the base, and in the Potter Farm formation near the top of the Traverse group, as well as in the Koehler and Charlevoix formations. Preliminary examination of the Koehler gastropods does not indicate that they are conspecific with those from the Charlevoix.

In the Lake Michigan area, the oölite bed of the Charlevoix is stratigraphically much higher than the *Chonetes emmetensis* zone of the Gravel Point, whereas the oölite bed observed in the Afton Quarry is below the Gorbut limestone, which in turn is below the *Chonetes emmetensis* zone (Fig. 3, columns D and E).

Gravel Point formation.—The Gravel Point formation was described by Pohl in 1930 (p. 5); he referred to it as the Gravel Point stage. Pohl included in his Gravel Point all strata below the Charlevoix limestone which is exposed in the Little Traverse Bay area. The lowest strata observed by Pohl are characterized by the occurrence of the brachiopod *Chonetes emmetensis*. The writers have examined the section in the area of exposures near Lake Michigan, and have compared both the lithologic character and the contained fauna of those sections with the sections exposed near Gorbut School, Cheboygan County, and believe them to be identical. This opinion was also borne out by G. A. Cooper (February 14, 1942) to whom samples of rocks and fossils were submitted.

The lower beds of the Gravel Point are exposed in the Campbell Stone Company Quarry north of Afton, in the small quarry northeast of the Gorbut School, and in the Marvin Quarry, about 2 miles southeast of the Campbell Stone Company Quarry. A section, measured along the north face of the Campbell

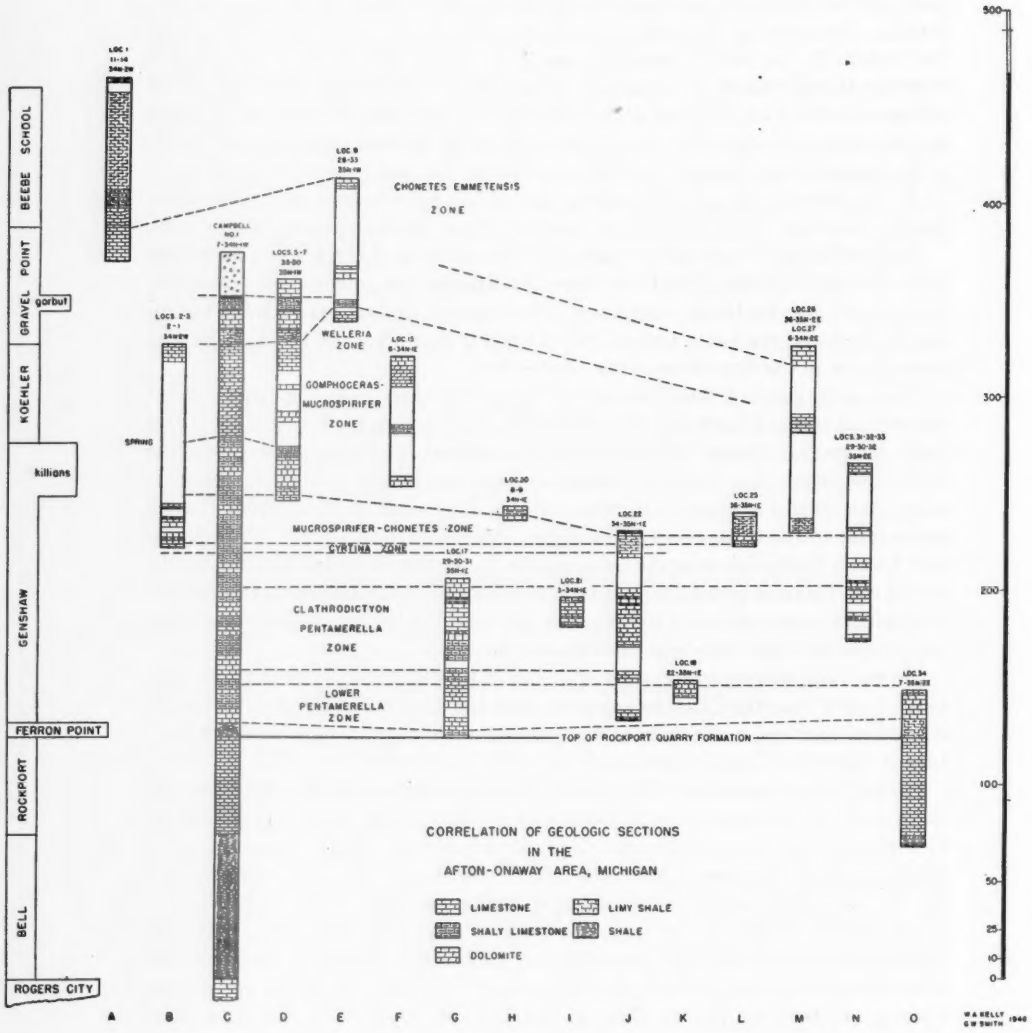

FIG. 3.—Correlation of geologic sections in Afton-Onaway area, Michigan.

Stone Company Quarry near Afton, is continuous with that exposing the Koehler formation.

	Feet	Inches
Overlying formation not exposed		
Bed 17—Massive, fine grained, gray stylolitic limestone. Coral *Hexagonaria* and brachiopod *Pentamerella* are most common fossils	9	6
Bed 16—Irregularly laminated, lenticular, dark gray to brown argillaceous limestone with many black shale partings	0	8
Bed 15—Irregularly laminated black shale and brown to black limestone, differing from bed above in greater proportion of limestone. Numerous crushed specimens of a long solitary coral, provisionally referred to *Heterophrentis*, occur in shale layers	6	
Bed 14—Black shale with lenticular black limestone layers	0	6
Bed 13—Compact, dense, dark gray limestone with scattered crinoid columnals	1	6
Bed 12—Massive, finely oölitic to finely granular buff limestone. Sparingly fossiliferous, but does include isolated gastropods and large heads of *Favosites*	7	6
Bed 11—Alternating thin layers of limestone, platy calcareous shale, and soft shale. This member is lenticular	1	4
Bed 10—Dark gray to black, dense limestone with abundant tests of ostracod *Welleria aftonensis*	0	10
Bed 9—Irregularly laminated, dense to finely granular gray limestone	4	10
Total	32	8
Bed 8—Underlying formation. Clay seam of Koehler formation.		

The section at the small LeGrand Quarry northeast of Gorbut School duplicates that in the Campbell Stone Company Quarry. The most characteristic part is a 10-foot member composed of alternating layers of dark-colored to black limestone and black shale, which correlates with beds 14, 15, 16 of the quarry north of Afton. Because it occurs in many parts of the area, this member is valuable in determining the approximate location of the Koehler-Gravel Point boundary. Its thickest development is in the small LeGrand Quarry, but since the name LeGrand is preoccupied for a stratigraphic unit of Mississippian age in Iowa, Gorbut is proposed for this Middle Devonian member in Michigan. The name Gorbut is taken from the school of that name, which is about ½ mile southwest of the quarry. The member is also exposed on the slope of the hill north of the Gorbut School, and serves to show the relation of the Koehler beds at the base of the hill to the *Chonetes emmetensis* zone of the Gravel Point formation near the summit of the hill (Fig. 3, column E, and Fig. 4).

The Gravel Point is also exposed in the Marvin Quarry, Sec. 7, T. 34 N., R. 1 W., and in the bottom of a ravine in Sec. 18, T. 34 N., R. 1 W.

The exposures at the Marvin Quarry are sufficiently different to warrant comparison. The section is briefly described.

	Feet	Inches
Overlying formation not exposed		
Bed 8—Massive, fine-grained, gray to buff limestone. Contains *Hexagonaria* n. sp., *Pentamerella* sp., *Creanena* sp.	6	
Bed 7—Biostrome made up principally of large laminar stromatoporoids	2	
Bed 6—Irregularly bedded massive gray limestone similar to bed 8. Contains stromatoporoids, coral *Hexagonaria*, and brachiopods	5	
Bed 5—Tan to gray massive limestone. Contains Bryozoa, Brachiopoda, Gastropoda, including *Tentaculites*	4	
Bed 4—Dark gray dense limestone with Ostracoda	1	
Bed 3—Black shaly limestone with irregular partings of soft flaky black shale	2	
Bed 2—Concealed interval	6	
Bed 1—Underlying formation—dense gray, cavernous, sub-lithographic limestone of Koehler formation		

Beds 6 and 7 of the Marvin Quarry are considered to be younger than bed 17 of the section north of Afton. Bed 3 of the Marvin section is correlated with the Gorbut member.

It is not known whether the concealed interval, bed 2, represents the Gravel Point or the Koehler. However, if we add the 6 feet to the Gorbut member, the maximum separation of the top of the Gorbut and Koehler is 8 feet, compared with the 22 feet which separate the top of the Gorbut and Koehler in the quarry north of Afton. Since no marked stratigraphic break exists at the base of the Gorbut, we can not attribute the absence of 14 feet of lower Gravel Point to erosion. The conclusion seems to be that the lowermost Gravel Point was not uniformly deposited over the post-Koehler surface. The amount of Koehler which was removed in the pre-Gravel Point interval can not be determined. Irregularity in contact has already been mentioned, and might account for uneven deposition of the lower Gravel Point. The evidence at present points to an erosional unconformity between the Koehler and the Gravel Point, comparable with, but not contemporaneous with, the stratigraphic break between the Charlevoix and Petoskey of the Little Traverse Bay area (Pohl, p. 19).

Beds of the Gravel Point, stratigraphically higher than bed 7 of the Marvin Quarry, do not crop out commonly in the area. Massive and thin bedded limestone and shale layers are exposed in the road ditch south of the Gorbut School, at an elevation of 60 feet above the outcrop of the Gorbut member which is $\frac{1}{2}$ mile north (Fig. 4). With prevailing dips toward the south, the stratigraphic thickness of the concealed beds is probably less than 60 feet. The limestone contains specimens of *Chonetes emmetensis* associated with *Mucrospirifer*, *Pholidostrophia*, and a small *Atrypa*. The fauna and the lithologic character link this area with that in the vicinity of Petoskey. Overlying the *Chonetes* zone are more massive beds containing *Hexagonaria percarinata*.

It is not known definitely whether the *Chonetes emmetensis* zone represents the highest Gravel Point strata that are exposed in the Afton area. Beds at, or near, the same stratigraphic horizon are exposed in the SE. $\frac{1}{4}$, Sec. 6, T. 34 N., R. 1 W. Exposures in the SW. corner of the SE. $\frac{1}{4}$, Sec. 18, T. 34 N., R. 1 W., have the lithologic and faunal characters of some beds in the Little Traverse Bay sections of the Gravel Point formation. The beds differ in detail from bed 16 of the Afton section, and it is assumed that they are somewhat higher in the section.

The upper contact of the Gravel Point occurs along the roadside about 2 miles south of Afton. Here a light-colored finely crystalline limestone is separated by a small covered interval from a coarsely crystalline, crinoidal limestone assigned to the Beebe School formation.

Detailed surveys of the structural geology in the Beebe School area suggest that the light-colored, finely crystalline limestone can not be much more than 40 feet above the top of the Koehler limestone. The contact of the Gravel Point and Beebe School formations is about 3,000 feet due south of the contact between the Gravel Point and the Koehler limestone, and is 40 feet lower. Imperfect exposures

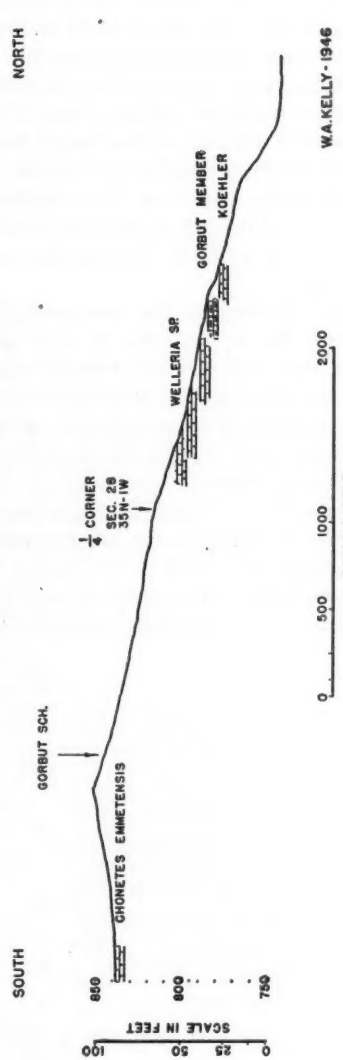

FIG. 4.—Geologic section along road south of LeGrand.

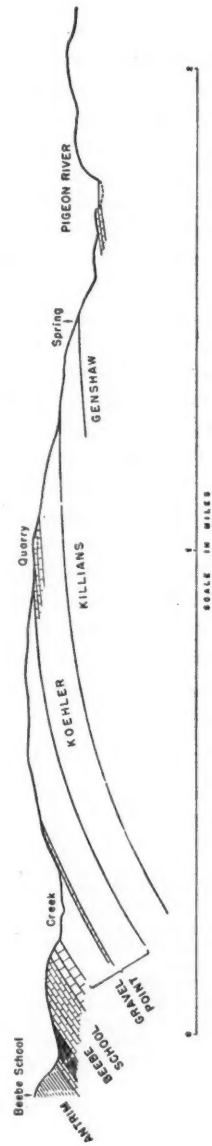

FIG. 5.—Profile extending north from Beebe School.

near the center of Sec. 11, T. 34 N., R 2 W., do not suggest that the strata are inclined as highly as they are in the southeastern part of the same section. In the southeastern part of the section the average component of the dip in a north-south direction is about 2½°, but in the northeast part of the same section the beds are almost flat. If we take an approximate mean of these two dip components, that is about 1¼° and allow for the change of elevation from the northern outcrop to the southern outcrop, an estimated thickness is about 60 feet (Fig. 5).

If the determination of 60 feet for the total thickness of the Gravel Point in the Afton area proves to be correct, it follows that a considerable portion of the Gravel Point of the Petoskey area is absent in the Afton area. This conclusion is partly supported by the lack of any indication of the rich fauna of the lower and upper blue shale members of the Gravel Point of the Little Traverse Bay area in outcrop or glacial drift within the Afton area.

Outcrops of white, massive, crystalline limestone on the road leading west from Onaway, as well as in a railroad cut in Sec. 6, T. 34 N., R. 1 E., may be Gravel Point in age. The beds exposed in these two localities overlie strata assigned to the Koehler formation, but differ in lithologic character from anything seen in the Afton area on the west. The character of the post-Koehler beds suggests the Alpena limestone of the Lake Huron shore vicinity section, rather than the Gravel Point limestone of the Lake Michigan shore vicinity section.

Beebe School formation.—The name Beebe School is applied to those limestone and shale beds which overlie the Gravel Point, and underlie the Antrim shale, and which are exposed on the front and back slopes of a series of low cuestas which trend in a northwest direction from Beebe School. The strata have not been recognized elsewhere. The formation may be conveniently subdivided into about four units.

	Feet	*Inches*
Overlying formation—Antrim shale		
Bed 4—Prevailingly thin-bedded, dark gray, weathering to light gray and buff, fine- to medium-textured limestone interbedded with shaly limestone and shale. Fossils common. Prevailing types are corals, stromatoporoids, Gastropoda, and a few Brachiopoda	20	
Bed 3—Yellow weathering calcareous shale interbedded with thin, highly fossiliferous, limestone layers. The most abundant fossils are short, long-winged *Mucrospirifer* and small, strongly costate *Stropheodonta*	30	
Bed 2—Thin-bedded light gray, brown weathering, cherty limestone with some very fossiliferous layers. Most fossils are Brachiopoda belonging to genera *Cyrtina*, *Mucrospirifer*, *Productella*, *Stropheodonta*, and *Craenena*. Some corals, including *Cylindrophyllum*	10	
Bed 1—Biostrome, massive, porous, and composed of unoriented coralla, fragmentary remains of crinoids, Bryozoa, and Brachiopoda. Matrix coarsely granular. Appears conformable with underlying limestone, separated by thin concealed interval	10	
Underlying formation—massive, fine-grained, gray limestone containing coral *Hexagonaria percarinata* (Sloss). Assigned to Gravel Point formation	70	

The thickness of each member of the Beebe School formation is difficult to measure because the bedding planes of many of the beds are imperfectly exposed, or show evidence of slumping, and the structural attitude can only be approximated.

A determination of 75 feet for the total thickness of the beds which the writers now refer to the Beebe School formation was made by Ulrich and Ehlers in 1926 (Ehlers, 1938, p. 10). At that time the road which passes the Beebe School was under construction and a minimum of bed rock was concealed.

Another determination of thickness was made by a plane-table survey of the structural relations of the limestone beds which cap the series of cuestas in the area in the NW. ¼, Sec. 14, T. 34 N., R. 2 W. From this information the north-south component of the dip between the biostrome, bed 1, 650 feet north of, and the outcrop of the upper limestone, bed 4, 50 feet south of the school corner, was determined to be 2½°. Since the top of bed 4 is topographically 47 feet higher than the base of bed 1, the computed thickness is 73 feet.

LOCALITIES OF OUTCROPS

The geographic location of the outcrops described in the following paragraphs are indicated by encircled numbers on the areal geologic map of the Afton-Onaway area (Fig. 1). The lower numbers are assigned to the southwest part of the area and increase toward the northeast.

Locality 1.—Discontinuous outcrops of the Beebe School and Gravel Point formations beginning in the drainage ditches on the north slope of the valley, 1,100 feet south of the Beebe School, and extending along the same road 2,100 feet north of the school. Exposures occur on both sides of the road, but are more extensive on the west side. Strata of the Beebe School are imperfectly exposed 550 feet along the road west of the school, and are separated by a concealed interval from the fissile black Antrim shale, which is exposed in a shallow excavation 1,050 feet west of the corner. Ledges of the silicified limestones (bed 2 of described section) are exposed on the dip slope of the cuesta for 900 feet. Details of the sections in this area are described under the headings of Gravel Point and Beebe School formations.

Locality 2.—Small quarry (Sorenson's Quarry) in the SE. ¼, Sec. 2, T. 34 N., R. 2 W., on the west side of the road. About 10 feet of almost horizontal beds of limestone are exposed. The limestone is characteristic of the Koehler formation, and includes porous and non-porous beds with semi-lithographic texture.

Locality 3.—Discontinuous outcrops of Genshaw limestone and shale in ledges along the Pigeon River from the old Elmer Dam downstream for about 1,500 feet. Located in Sec. 1, T. 34 N., R. 2 W. Total thickness of section—21 feet.

Locality 4.—Outcrops of Genshaw limestone along the north bank of the Pigeon River, about 1,300 feet west and 1,200 feet south of the NE. corner of Sec. 2, T. 34 N., R. 2 W. Higher beds of the Genshaw are exposed at a spring about 30 feet up the valley slope, about 600 feet west and 500 feet south of the same corner. The section is continued 1,000 feet north of the corner, where a bed of black limestone of the Killians member is exposed. The outcrop is about 50 feet west of the section line.

Locality 5.—Quarry of the Campbell Stone Company, exposing Koehler and Gravel Point formation. This section has been described elsewhere in this report. Beds of the Koehler are also exposed on the slope of the small valley which cuts diagonally across the E. ½ of Sec. 36, T. 35 N., R. 2 W.

Locality 6.—Exposure of 2 feet of Genshaw limestone along the southern branch of Little Pigeon River, where that stream crosses the W. line of Sec. 24, T. 35 N., R. 2 W.

Locality 7.—Genshaw-Killians contact. Exposures chiefly in road cuts along the southern lines of Sec. 19, T. 35 N., R. 1 W., and Sec. 24, T. 35 N., R. 2 W. The best exposure of the Killians limestone in the Afton area occurs on a hill in NW. ¼, Sec. 30, T. 35 N., R. 1 W. About 25 feet of Killians and 2 feet of sub-Killians Genshaw are exposed. The Killians is close to the surface in the SW. corner of Sec. 20, T. 35 N., R. 1 W.

Locality 8.—Isolated exposure of 5 feet of buff granular dolomitic limestone provisionally assigned to the Newton Creek formation. The outcrop is about ¾ mile south of the NW. corner of Sec. 29, close to where an abandoned railroad track crosses the section line between Secs. 29 and 30, T. 34 N., R. 1 W.

Locality 9.—Outcrop of the Koehler and Gravel Point along the escarpment south of LeGrand, located principally in Secs. 28, 29, and 33, T. 35 N., R. 1 W. The interrupted exposures on the highway extend from a point 1,200 feet south of the NW. corner of Sec. 28, to the shallow valley 1,200 feet

south of the Gorbut School and are shown in Figure 4. Locality 9 also includes both the LeGrand Quarry located on the eastern face of the bluff formed where the escarpment has a southerly trend, and the massive limestone in the abandoned railroad cut found both ½ mile east of, and 500 feet south of, the Gorbut School corner.

Locality 10.—Outcrops of the dense, sub-lithographic limestone of the Koehler formation in the bed and along the banks of the small stream in the SE. ¼, Sec 33, T. 35 N., R. 1 W.

Locality 11.—Exposure of massive fossiliferous limestone of the Gravel Point formation, similar to that which overlies the Gorbut member, in the roadbed of Michigan Highway No. 33 about ⅝ mile east of the SE. corner of Sec. 33, T. 35 N., R. 1 W.

Locality 12.—Exposures of Koehler and Gravel Point formation in the Marvin Quarry in the NE. ¼, Sec. 7, T. 34 N., R. 1 W. The section is described elsewhere in this report. The strata outcrop along the east-west road north of the quarry as far east as the school, and also along the northeast trending scarp in the SE. ¼, Sec. 6, T. 34 N., R. 1 W.

Locality 13.—Outcrops of black limestone and shale of the Gorbut member in the bottom of a ravine which crosses the line between Secs. 17 and 18, T. 34 N., R. 1 W., about ⅛ mile south of the quarter line. Total thickness of the section about 7 feet.

Locality 14.—Outcrops of thinly bedded, fine- to medium-grained limestone interbedded with calcareous shale along the roadside in the SE. ¼ of Sec. 18, T. 34 N., R. 1 W. The section includes a 1-foot bed of dense black shale. Exposures of massive limestone, ¼ mile north, occur in the fields. The entire section is about 5 feet thick. Fossils characteristic of the Gravel Point are abundant.

Locality 15.—Ledges of black Killians limestone below water level of Milligan Creek, where that stream is crossed by State Highway 33, Sec. 6, T. 34 N., R. 1 E. The exposures are continued along the roadside toward the east. A concealed interval separates them from sub-lithographic and cavernous limestone of the Koehler formation in the SE. ¼ of Sec. 6. Float of the Koehler formation is abundant ¼ mile south of the SE. corner of Sec. 6.

Locality 16.—Outcrop of dense sub-lithographic limestone of the Koehler formation in the upper part of the bluff in the NE. corner of Sec. 5, T. 34 N., R. 1 E.

Locality 17.—Exposures of the upper Ferron Point, and the lower and middle parts of the Genshaw formation along the bed and banks, and in places along the valley walls of Milligan Creek. One small exposure occurs in a miniature sink-hole on the north side of the road, 900 feet east of Waverly School No. 4. The Rockport Quarry limestone is exposed in the bed of Milligan Creek where that stream is crossed by the bridge of the Detroit and Mackinac Railroad, and the highest bed of the Genshaw is exposed in a high bluff in the north-central part of Sec. 31, T. 35 N., R. 1 E., where the Milligan makes an abrupt turn from a southeasterly to an easterly course. Limestone is exposed in the bed of the creek as far up the stream as the western boundary of Sec. 31, but the limestone exposed in that section is believed to be stratigraphically lower than the highest beds in the bluff previously mentioned. An estimated thickness of about 85 feet of Ferron Point and Genshaw lies between the lower and upper limits of the section. Some of the beds are highly fossiliferous.

Locality 18.—Section exposing 13 feet of lower Genshaw on the north face of an east-west bluff known locally as Limestone Hill. The beds are best exposed ¼ mile north of the SE. corner of Sec. 21, along the unimproved road which follows the line between Secs. 21 and 22, T. 35 N., R. 1 E.

Dense, semi-lithographic limestone of the Rockport Quarry formation is exposed in the bed of an intermittent creek near the center of Sec. 22. This outcrop occurs in the glacial lake plain north of the bluff.

Locality 19.—The upper part of the Rockport Quarry limestone is exposed intermittently in the bed and along the banks of the Black River for a distance of about 1 mile in Secs. 28 and 33, T. 35 N., R. 1 E., and forms a series of rapids, known locally as Shanty Rapids. The exposures are separated by a quiet portion of the stream from the ledges of the lower Genshaw in Sec. 33. There are a number of small anticlinal and synclinal undulations which make determination of the thickness of the exposures difficult. There is probably a total of 15 feet of beds exposed.

Locality 20.—Exposures of about 6 feet of the Killians member of the Genshaw are found in the roadside ditch, NW. corner of Sec. 9, T. 34 N., R 1 E., and the small inlier of sub-Killians Genshaw in the ditch on the south side of State Highway 33, opposite the end of the blind road at the NE. corner of Sec. 8, T. 34 N., R. 1 E.

Locality 21.—About 17 feet of Genshaw limestone and shale is exposed below the Tower Dam in Sec. 3, T. 34 N., R. 1 E., along the Black River. This section is typical of the Genshaw and easy to reach from Michigan Highway 33. Beds of the Killians are exposed about ½ mile east. The Killians occurs at a higher elevation along the roadside about ½ mile south of the NE. corner of Sec. 3.

Locality 22.—Discontinuous exposures of fossiliferous limestone and shale of the Genshaw formation at the north and south, as well as on the face of the bluff crossed by the road which follows the center line of Sec. 34, T. 35 N., R. 1 E. The total thickness of the beds exposed is difficult to determine because of the relatively long distance between outcrops. A probable interpretation, which accords with available structural information, indicates that nearly 100 feet of strata separate the lowest and highest beds. The highest beds are assigned to the lower part of the Killians member.

The bluff trends in an easterly direction, and about ¼ mile south of the NE. corner of Sec. 34, forms a conspicuous landmark. The top of the bluff is capped by massive limestone with conspicuous crinoid columnals in a dark gray matrix. These beds may represent the Killians member. The lower Genshaw is exposed near the base of the bluff.

Locality 23.—Exposures of about 8 feet of bedded, dark gray limestone in the SW. ¼, Sec. 23, T. 35 N., R. 1 E. The outcrops extend east and west throughout a distance of about 600 feet. The lower bed forms the cap rock of a perennial spring. Fossils include abundant stromatoporoids, in addition to simple and colonial corals. The beds are referred to the lowermost Genshaw.

Locality 24.—Excavation exposing irregularly bedded shaly limestone, and calcareous shale, containing the rich fauna characteristic of the Ferron Point shale. The exposure is 800 feet south, and 400 feet west of the NE. corner of Sec. 26, T. 35 N., R. 1 E.

Locality 25.—The top of the sub-Killians Genshaw, as well as the basal part of the Killians member forms a series of low cuestas in the NE. ¼, SW. ¼, Sec. 36, T. 35 N., R. 1 E. The steep face of the cuestas is toward the north.

Locality 26.—Exposures of massive black limestone, interbedded with black shale, of the Killians member along the roadside in the SE. ¼, Sec. 36, T. 35 N., R. 1 E. South of the Killians exposure, the road follows the township line between Secs. 6 and 1. Glacial deposits, containing a large proportion of Koehler limestone are exposed in road-cuts about ¼ mile south of the Killians outcrop.

Locality 27.—Massive, crystalline, white to light gray limestone is exposed in a railroad cut about ⅝ mile south of locality 26 in the SW. ¼, NW. ¼, Sec. 6, T. 34 N., R. 2 E. It is sparingly fossiliferous, and the fauna includes a species of *Hexagonaria* allied to *H. percarinata* of the Gravel Point.

Locality 28.—Discontinuous outcrops of massive, crystalline white limestone occur on both sides of State Highway M-33 for a distance of ½ mile from the SW. corner of Sec. 6, T. 34 N., R. 2 E. Some of the limestones lack stratification and suggest a reef facies. Few fossils, other than flat stromatoporoids, colonial and simple corals, occur. The presence of a variety of *Hexagonaria* closely allied to form found elsewhere only in the Gorbut member, suggests an age equivalent to the Gravel Point.

Locality 29.—Ledges of Killians black limestone below water level on the upper part of Black River in the E. ½, Sec. 13, T. 34 N., R. 2 E. This is the most southerly exposure of bed rock in the area.

Locality 30.—Outcrop on east side of State Highway M-211, in the NW. ¼, SW. ¼, Sec. 32, T. 35 N., R. 2 E. Exposure of 1½ feet of black shaly limestone and black brittle shale, containing a large *Atrypa*, *Pentamerella*, small strongly costate *Stropheodonta*, and abundant *Pholidostrophia* of the Killians member overlain by nearly 2 feet of gray granular limestone. The upper bed resembles the section exposed at locality 32.

Locality 31.—Outcrop of the middle portion of the Genshaw north of Rowe School in Sec. 29, T. 35 N., R. 2 E. Limestone is exposed intermittently along low escarpments trending N. 40° W. on the west side of the valley of Stoney Creek, almost to the corner of Sec. 29. The exposures and escarpments continue westward almost to locality 33. Locality 31 includes outcrops found along the adjacent State Highway M-211 as far north as Stoney Creek. A total of about 40 feet of strata is exposed.

Locality 32.—About 4 feet of bituminous black shaly limestone assigned to the Killians is overlain by 2 feet of fossiliferous tan to light brown crystalline limestone 180 feet south of the SE. corner of Sec. 30, T. 35 N., R. 2 E., 1½ miles north of Onaway. Because its fauna resembles that of the Genshaw rather than that of the Newton Creek, this limestone is tentatively assigned to the upper Genshaw.

Locality 33.—Intermittent exposures of approximately 22 feet of Genshaw found along an escarpment trending approximately east-west in SE. ¼, Sec. 25, T. 35 N., R. 1 E. The best outcrop is along the road 1,100 feet south of the W. ¼ corner and extends to the escarpment at the E. ¼ corner of Sec. 30, T. 35 N., R. 2 E.

Locality 34.—Composite section of the Rockport Quarry, the Ferron Point, and the lowest beds of the Genshaw obtained from exposures in the abandoned quarry of the Onaway Limestone Company at Black Lake, and in the cliffs along the south shore of the lake, Sec. 7, T. 35 N., R. 2 E. The quarry face exposes sharply inclined limestone of the Rockport Quarry and shale of the Ferron Point formations. The section is continued along the lakeshore north of the quarry, where the Rockport Quarry limestone disappears below the lake surface, and is succeeded in the lake bluffs by the Ferron Point shale, and the basal 17 feet of the Genshaw limestone.

The same section is imperfectly exposed on the east-west road through the middle of Sec. 7.

STRUCTURAL GEOLOGY

The Afton-Onaway area is in the north-central part of the Michigan structural basin (Newcombe, 1933, Pl. III). The regional dip calculated from Newcombe's structural contour map is about 30 feet per mile toward the southwest. That the regional dip is very gentle is substantiated by the fact that the greater part of the Traverse group—from near the base of the Rockport Quarry forma-

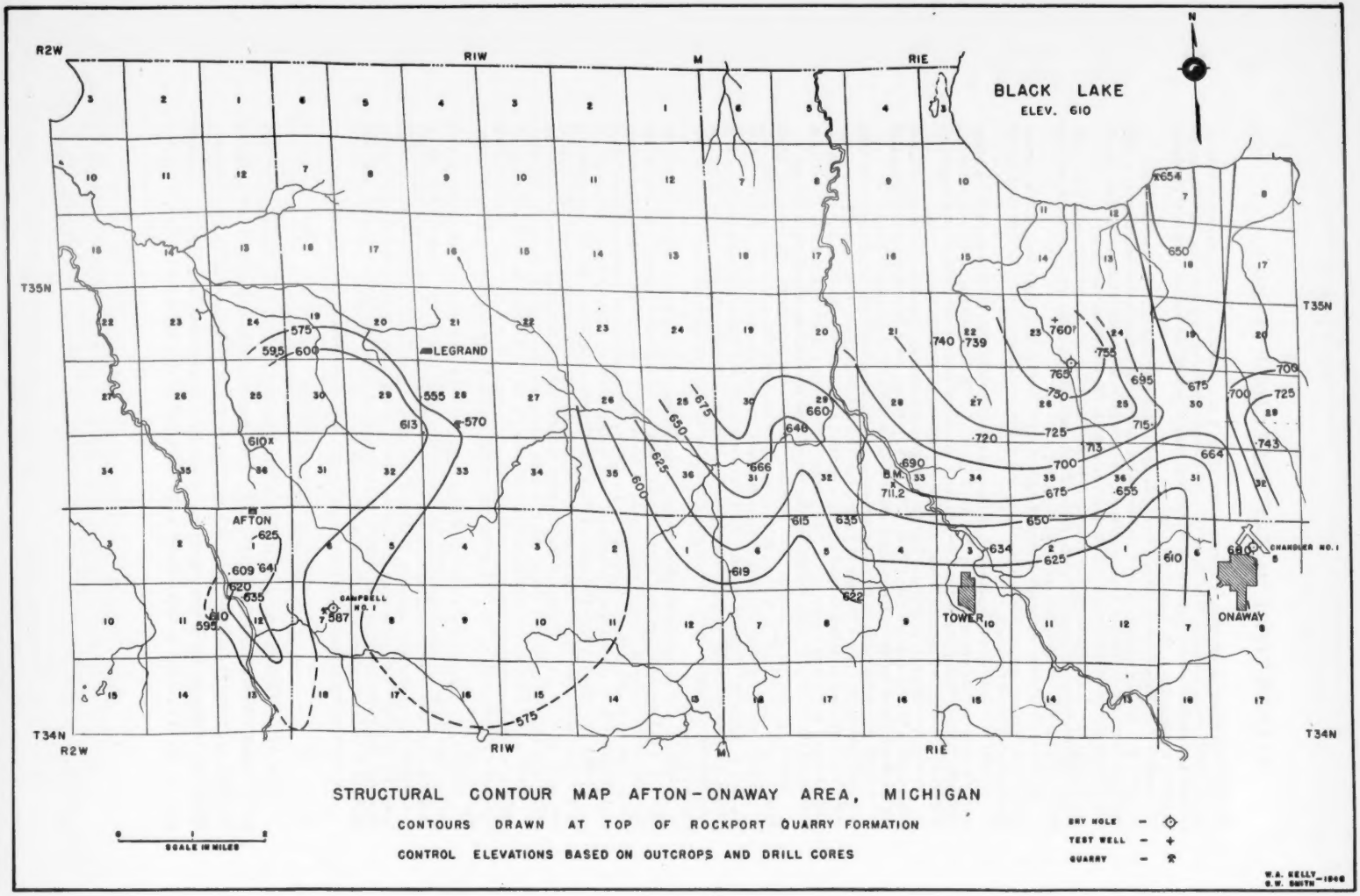

FIG. 6.—Structural contour map of Afton-Onaway map area, Michigan. Contours drawn at top of Rockport Quarry formation. Contour interval, 25 feet.

tion to the base of the Antrim shale—is exposed between Black Lake and the Antrim outcrop near the center of Sec. 14, T. 34 N., R. 3 W. (Fig. 1). The elevation of the lowest exposed bed in the Rockport Quarry formation, estimated to be 20 feet above its base, is 610 feet at Black Lake. The elevation at the base of the Antrim about 15 miles southwest of Black Lake, in the center of Sec. 14, T. 34 N., R. 2 W., is 795 feet. Consequently, there is a maximum difference in elevation between the two outcrops of only 185 feet. The Traverse group, with the exception of the Bell shale and Lower Rockport Quarry formation, crops out intermittently from Black Lake to the Antrim exposure. This higher portion of the Traverse has a minimum thickness of about 280 feet, as indicated by a study of the samples obtained from the Francis Oil Company's Campbell well No. 1 in Sec. 7, T. 34 N., R. 1 W. To this figure we must add at least the thickness of the Beebe School formation, 75 feet, which gives a conservative estimate of 355 feet. Thus there is too great a thickness of rock to be exposed in the 185 feet difference in elevation unless there is a dip of about 20 feet per mile southwest. Because of the many minor and subordinate flexures in the area, local dips may exceed 20 feet per mile, but there are also local dips which oppose the regional dip. Consequently, 20 feet per mile is merely an average of these local inclinations.

Minor flexures in the strata can be observed in the Afton Quarry and along Milligan Creek. Exposed strata in the valley of the Milligan change direction of dip every few hundred feet. The significance of these flexures is obscure, and attention of the writers was directed principally to structural features which are of greater areal extent than the minor flexures previously mentioned. The larger structures superimposed on the regional dip are indicated by a structural contour map (Fig. 6).

The contours of this map are drawn on top of the Rockport Quarry formation, because the dense, buff, lithographic limestone at the top of this unit is readily recognizable in both well samples and outcrops. Most of the elevations on the Rockport Quarry limestone were obtained by subtracting the thickness of strata between the Rockport Quarry and some marker zone or formation, from the surface elevation of the marker. Because the most common outcrops are those of the Genshaw formation, and because the individual beds of this formation possess no distinctive lithologic characters, it was necessary in this investigation to depend mainly on faunal zones as markers. The zone fossils possess a stratigraphic range of several feet, and thus introduce a variable factor. As a result, the elevations determined for the top of the Rockport Quarry formation are necessarily correct only within the limits possible in determining the stratigraphic position of the faunal zones. In most calculations the possible error is considered to be less than 7 feet. This method of determining elevations is not exact, but it is the only method feasible for scattered exposures of small vertical interval in this area. Subsurface elevations from several wells in the area substantiate the conclusions derived from surface data. Those elevations on the structural contour map which do not coincide in geographic location with locality numbers on Figure 1 are from subsurface data obtained from wells.

FIG. 6.—Structural contour map of Afton-Onaway map area, Michigan. Contours drawn at top of Rockport Quarry formation. Contour interval, 25 feet.

Structural features shown on Figure 6 include from west to east: the Pigeon River anticline; an unnamed syncline; a small structural nose; a minor syncline; and the major structural feature in the eastern half of the map, the Black Lake anticline, which is bordered on the east by the Onaway syncline.

The presence of the Pigeon River anticline in the southwestern part of the Afton-Onaway area is denoted by several lines of evidence. The *Chonetes-Muscrospirifer* beds of the Genshaw formation have an elevation 40 feet higher at the Locality 3 than in the SW. ¼, Sec. 19, T. 35 N., R. 1 W. There is, then, a rise in elevation to the south from the outcrops in Section 19. A marked southeast dip from the Francis Oil Company's Vizina No. 1 (SE. ¼, Sec. 1, T. 34 N., R. 2 W.) to the same company's Campbell No. 1 (NE. ¼, Sec. 7, 34 N., R. 1 W.) is attested by a 50-foot drop in elevation on the top of the Rockport Quarry formation. A local east dip is shown by the downdip swing of the Gorbut member where it crosses the ravine in the SE. ¼, SE. ¼, Sec. 7, 34 N., R. 1 W. A dip to the southwest is indicated by the cuestas north of the Beebe School and also by the presence of Koehler, Gravel Point, and Beebe School beds between the Genshaw outcrops on the Pigeon River, elevation 745 feet, and the Antrim outcrop, elevation 795 feet, in Sec. 14, T. 34 N., R. 2 W. The thickness of strata represented by the three formations, about 170 feet, could not be fitted into the vertical distance between these outcrops without a definite southeast dip because there is insufficient topographic relief.

No closure of the contours to the northwest is positively indicated, but closure is probably present. The outcrops of the limestone in the NE. ¼, Sec. 2, T. 34 N., R. 2 W., near the top of the lower Genshaw is at an elevation of 770 feet. Subtracting an interval of 125 feet for the combined lower Genshaw and Ferron Point (Fig. 3) the calculated elevation of the Rockport is 645 feet. The elevation of the Rockport would be increased at this location if the Genshaw-Killians contact occurs above 770 feet. The upward range of this contact is controlled by an elevation of 810 feet, at the outcrop of Killians limestone along the line between Secs. 35 and 36, T. 35 N., R. 2 W.

A broad shallow syncline with a north-south axis is shown on the structural contour map. The axis is about 3 miles west of the principal meridian, but can not be more than approximately located because of the absence of outcrops in this axial area. The presence of a synclinal structure, however, is indicated by the controlled contours on each side of the meridian. In addition, the change in strike of the formations from northeast to northwest at the northern end of this syncline lends support to the structure as contoured. This syncline is bordered on the east by a small structural high which does not possess a north closure.

A small syncline with a north-south axis roughly parallel with the line bebetween Secs. 31 and 32, T. 35 N., R. 1 E., is suggested by the difference in elevation of, and by the northward re-entrant of, the top of the Killians in Secs. 5 and 6, T. 34 N., R. 1 E.

The largest structural feature in the eastern part of the area is located south

of Black Lake, and is referred to as the Black Lake anticline. No closure can be proved for the north end of this structure because of glacial overburden and the lack of drilling data. Relatively strong dips in every other direction away from the probable crest in the NE. ¼, Sec. 26, T. 35 N., R. 1 E., and the directional trend of the contours on the northeast and western sides of this structure are such as to warrant reference to it as an anticline.

The surface expression of the anticline consists of a broad south re-entrant of the escarpment formed by the upper Genshaw and, less commonly, the Killians. The escarpment swings southwesterly from the center of the W. line of Sec. 29, 2 miles north of Onaway, through Secs. 30 and 31, the S. ½ of Sec.36, and thence northwestward to Sec. 34, 1½ miles north of Tower.

The contour lines outlining the Black Lake anticline are based on several lines of evidence. Relatively steep inclinations which can be observed in the abandoned quarry of the Onaway Limestone Company persist for a minimum distance of 400 feet. The strike is N. 30° W., and the dip 8° in a northeasterly direction, as determined from three elevations on the Rockport Quarry—Ferron Point contact. The clearest evidence, however, is furnished by the elevations of 610, 770, and 680 feet, respectively, for the Rockport Quarry-Ferron Point contact at the Black Lake Quarry (Loc. 34) in the shallow excavation in Sec. 26 (Loc. 24), and the rapids of the Black River (Loc. 19).

Elevations were also determined at localities where the beds of the *Clathrodictyon-Pentamerella* zone crop out. Since this zone is 45 feet thick, a fairly large error is introduced if the section exposed is isolated or thin. Control factors, such as nearby outcrops of the Killians, or the presence of an extensive sequence of beds, are afforded.

Additional evidence is also furnished by the logs of wells which have been drilled for oil or for structural information. Numerous water wells drilled commonly to the Rockport Quarry formation or the Bell shale, have also been useful in contouring the Black Lake structure.

A small saddle southeast of the Black Lake anticline occupies a position nearly in the center of the north-south trending Onaway syncline. The Onaway syncline is inferred from several facts. The isolated outcrop, at the NE. corner of Sec. 31, T. 35 N., R. 2 E., of tan, crystalline limestone overlying the Killians member would not crop out at an elevation of 824 feet unless there was a downward flexure of strata to the west or a sudden thinning of the underlying formation. No evidence of a marked unconformity in the sequence exists and the writers are inclined to discount this possibility. Beds of the *Clathrodicyton-Pentamerella* zone crop out at the Rowe School less than ½ mile to the east at an elevation of 808 feet. If we assume that the highest beds of the *Clathrodictyon-Pentamerella* zone are exposed we shall still have to allow for the disappearance of 60 feet of strata, namely, the upper part of the lower Genshaw and the Killians member. Beds of the Killians member are imperfectly exposed in a narrow belt between the two localities.

The upper part of the log of the Presque Isle Development Company well in the SE. corner of the NW. ¼, Sec. 5, T. 34 N., R. 2 E. furnishes further evidence of a syncline. It is reproduced from the state geologist's report on the oil and gas possibilities of Michigan (Smith, R. A., 1914).

Elevation, 830 feet	Feet Thickness	Depth
Pleistocene		
1. Pink calcareous clay	10	10
2. Gray limestone; moderate effervescence	15	25
3. Buff and dark gray limestone, and very argillaceous limestone; violent effervescence	100	125
4. Gray granular; bituminous; fossiliferous crinoids and corals, violent effervescence, much white calcite	15	140
5. Soft calcareous gray shale	10	150
6. Gray limestone with much disseminated calcite; fossiliferous (corals); vigorous effervescence	20	170
7. Dark limestone; highly calcareous black shale, disseminated calcite	80	250
8. Gray, brown and black shale, slightly calcareous	60	310

The beds below this are referred to the Dundee and older formations, with which this report is not concerned.

From this log one can readily pick out the Bell shale from description 8. The Rockport Quarry limestone is apparently represented by descriptions 6 and 7 and the Ferron Point by description 5. The Rockport Quarry formation is represented here, in part at least, by the black facies. This places the top of the Rockport Quarry at an elevation of 680 feet and helps establish the eastern limb of the syncline.

An outcrop of Gravel Point, or at least post-Koehler limestone in the railroad cut in the west half of Sec. 6, T. 34 N., R. 2 E., gives reason for believing that there is a relatively sharp south component of dip on the west limb of the Onaway syncline. The outcrop of Gravel Point is only one mile southeast of the Killians member which forms the low cuestas in the SW. ¼, Sec. 36, T. 35 N., R. 1 E. There in only 8 feet of difference in elevation between these outcrops, and at least 45 feet of strata occur between the two. The disappearance of this thickness of rock, substantiates the direct evidence of the southerly dipping Killians.

Dips toward the south, probably components of a southwest dip, were recorded on the Genshaw limestone at Tower Dam, and on a thin remnant of the Killians member 1½ miles north of Tower. A southeast dip was measured on the top of the Rockport exposed at Shanty Rapids, Sec. 33, T. 35 N., R. 1 E.

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BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
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SEDIMENTATION IN PERMIAN CASTILE SEA[1]

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ABSTRACT

The Permian Castile formation is a favorable starting point for a study of precipitated marine sediments because of its relatively simple stratigraphy. It is 1,300 to 2,000 feet thick and consists principally of "banded" or laminated anhydrite, but it contains some salt and other materials. It was deposited within the deep steep-walled Delaware Basin of western Texas and southeastern New Mexico. Throughout Castile time communication with the open sea was maintained through a restricted channel near the southwest corner of the basin. Paucity of detrital material indicates that the deposit consists almost exclusively of marine evaporites.

It is suggested that the water within the basin consisted of a body of brine lying below average wave base and a less dense surface layer lying above average wave base. Some of the dense brine continuously returned to the open sea; otherwise the volume of halite deposited would have been about 30 times as great as the volume of anhydrite instead of somewhat less than the volume of anhydrite. The barrier must therefore have been incomplete. Either the top lay partly below wave base or the barrier was permeable. This theory of reflux is presented as a modification of Ochsenius' bar theory.

The calcium sulphate presumably was deposited as anhydrite rather than as gypsum because of the salinity of the brine. The banding is ascribed to seasonal variation in temperature. The average net rate of evaporation in Castile time is calculated as 114 inches a year.

INTRODUCTION

The chief purpose of this paper is to stimulate interest in and discussion of the deposition of precipitated sediments. Mere passive acceptance or prejudiced rejection of the reasoning and conclusions would be disappointing. The subject holds more than academic interest, for any data pertaining to chemical precipitates, and any inferences that may be drawn therefrom, have a bearing on the deposition of potassium salts and other saline minerals.

The Castile formation was deposited within the Delaware Basin near the end of Permian time. The area originally covered by Castile rocks includes all of Loving and Reeves counties and parts of Pecos, Ward, Winkler, and Culberson counties, Texas, and parts of Eddy and Lea counties, New Mexico (Kroenlein, 1939, Fig. 1; King, 1942, Fig. 33). The basin is 165 mile long (north-south) and 96 miles wide (Adams, 1944, p. 1598).

The Castile formation consists principally of "banded" or, more correctly, laminated anhydrite. It contains some small calcite lenses, some massive anhydrite, and some halite (Adams, 1944, pp. 1603–08). A basal layer a few feet thick is calcareous (King, 1942, p. 611). The thickness of laminated and massive anhydrite ranges from 700 feet at the north end of the basin to 1,800 feet at the south end, and averages 1,250 feet. Halite is most prominent in the northern part of the basin, where it locally reaches a maximum thickness of 900 feet. The thickness of the Castile formation as a whole ranges from 1,300 feet at the north end of the basin to 2,000 feet at the south end (Kroenlein, 1939, p. 1686). Adams (1944, p.

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[2] Geological Survey.

1604) states that the "average" thickness is between 1,500 and 1,850 feet and that the maximum exceeds 2,100 feet.

Two main problems are considered. Perhaps the more controversial is the problem of accounting for the scarcity of salt in the formation, which is present in insignificant quantity in comparison with the great amount of anhydrite, as contrasted to the large ratio of sodium chloride to calcium sulphate in sea water. A modification of Ochsenius' bar theory, termed the theory of reflux, is offered to account for this discrepancy.

The second major problem is the original composition of the calcium sulphate, whether anhydrite or gypsum. Reasons are given for believing that it was anhydrite.

Some inferences on the nature of the barrier and a computation of the average rate of evaporation are also offered.

Discussion is restricted to the Castile formation because the sediments of that age were subjected to the fewest complicating factors during their depositional and post-depositional history. The boundaries of the area are well defined, the stratigraphy of the formation has been revealed by numerous drill holes, and the region has escaped violent tectonic movement, so that the deposits remain unaltered except by weathering.

GEOLOGICAL AND CHEMICAL DATA

Geologic history.—As a result of the slight regional uplift that occurred at the close of Guadalupe time, the Permian sea withdrew from a large area in southeastern New Mexico and western Texas, and during Castile time it occupied only the Delaware Basin in that area. The Delaware Basin had already received nonsaline Permian sediments of great thickness prior to Castile time, but it continued to subside, so that throughout Castile time the water was several hundred feet deep (Adams, 1944, pp. 1598, 1617). Within the basin deposition was continuous, although the change in lithologic character was abrupt. The steep basinward face of the Capitan reef, which formed during Guadalupe time and rose 1,200 to 2,000 feet above the basin floor (Adams, 1944, p. 1598), constituted the margin of the basin. Because the sides of the basin were nearly vertical, the area covered by Castile sediments coincided almost exactly with the area of the water surface that was exposed to evaporation. Communication with the open sea was maintained through a shallow channel at the southwest corner of the basin (King, 1942, pp. 758–59).

At the end of Castile time the sea withdrew still farther, so that locally an erosional unconformity separates Castile sediments from the overlying Salado formation (Adams, 1944, p. 1608).

Laboratory data on evaporation of sea water.—Usiglio's data, recomputed by Clarke (1924, pp. 220–21) in more commonly used units, indicate that when a sample of sea water is evaporated, iron oxide and calcium carbonate begin to precipitate before the volume has been reduced by half. When the volume has

been reduced to 19 per cent of the original volume, all the calcium carbonate and about one-third of the calcium sulphate are precipitated. When the volume is further reduced to 9½ per cent of the original volume, more than 85 per cent of the calcium sulphate is precipitated, together with slightly more than 10 per cent of the sodium chloride and traces of more soluble compounds. At this point, however, the weight of sodium chloride precipitated already amounts to more than twice the weight of calcium sulphate precipitated. The total volume of sodium chloride precipitated by complete evaporation of sea water is about 30 times as great as the total volume of calcium sulphate calculated as anhydrite.

Solubility of calcium sulphate.—The solubility of anhydrite in water decreases as the temperature increases. Addition of sodium chloride up to about 6 per cent increases the solubility of calcium sulphate in either form at 30°C., but further addition of sodium chloride decreases the solubility of calcium sulphate. In sea water at 30°C., gypsum is less soluble than anhydrite until the volume has been reduced to about 20.8 per cent of the original volume, but thereafter anhydrite is the less soluble form, and further evaporation yields anhydrite (Posnjak, 1940, pp. 564–65). At 42°C. only anhydrite is precipitated at any concentration (Posnjak, 1938, p. 268).

INFERRED DEPOSITIONAL PROCESS

That the anhydrite comprising most of the Castile formation is a chemical precipitate rather than a detrital deposit is a generally accepted belief, but the probable process of deposition has not been fully discussed.

Source of material.—The shallow-water foreland-facies deposits of Guadalupe age, which were exposed to subaerial erosion after the withdrawal of the sea into the Delaware Basin, consist chiefly of detrital materials, dolomite, and gypsum. These beds probably were the source of the minor amount of clastic material contained in the deposits of the Castile formation, and of a comparable amount of chemically precipitated material. That any major portion of the Castile sediments was derived from this source, however, seems unlikely. The ratio of clastic to precipitated sediments in the Castile formation is very small, whereas the reverse would be expected if the mode of transportation were predominantly terrestrial water or wind. Furthermore, the older strata do not show evidence of erosion extensive enough to account for the great mass of anhydrite that constitutes most of the Castile formation. It seems likely, therefore, that the chemical precipitates of the Castile were derived principally from evaporating marine waters, and that the clastic deposits and possibly a minor part of the chemical precipitates were introduced by terrestrial water or wind.

Distribution of water density.—Evaporation takes place only from the surface of a body of water. In that part of a body of water that lies above wave base and which is termed the surface layer, wave action mixes the water so that uniform density is maintained from top to bottom of the surface layer, although not necessarily throughout the horizontal extent of the layer.

In an isolated body of water the density of the surface layer increases as evaporation proceeds, but simultaneously the denser liquid tends to settle by gravity, so that vertical uniformity of density throughout the entire depth is approached if not quite attained. If evaporation from one part of the surface is more rapid, tending to produce a denser column of water beneath that part, such water also moves horizontally, displacing lighter less concentrated solution, so that horizontal uniformity of density is also approached.

In Castile time the Delaware Basin, in which the Castile sediments were deposited, was not completely isolated, but was connected by a channel to the

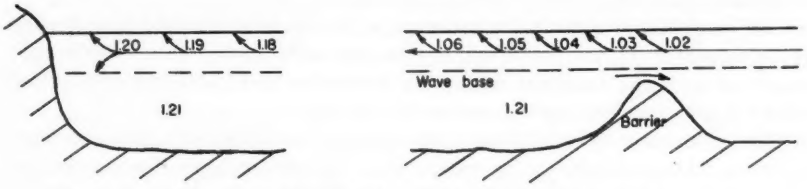

FIG. 1.—Profile through Delaware Basin indicating distribution of water density and direction of movement of water in Castile time.

open sea on the southwest. New sea water could enter the basin to replace the water lost by evaporation. Movement of water from the sea to the basin was not only possible but necessary to maintain the hydrostatic equilibrium between the two bodies of water. The normal sea water entering the basin was obviously less dense than the water already in the basin, which had been concentrated somewhat by evaporation; hence the new water tended to flow over the residual brine. As the new water was subjected to evaporation it became more dense, but as its density reached that of the underlying water the two mingled, so that throughout the basin the new water remained on top of the residual brine until the new water had been concentrated to a density equal to that of the brine.

Only at the entrance of the basin was the new water normal sea water. As it flowed toward the farther edges of the basin it became a progressively more concentrated solution of various salts, its density continually increasing. Inasmuch as the underlying brine was, in effect, an isolated body, presumably its density was virtually uniform throughout. Only at the innermost shores of the basin, therefore, would the water of the surface layer attain sufficient density to sink and mingle with the brine already present. Conversely, the maximum density attained by the surface layer would determine the density of the underlying brine.

In summary, the Delaware Basin probably contained, during Castile time, a body of brine of approximately uniform density, and an overlying surface layer that was less dense than the brine and that increased in density with distance from the entrance.

Theory of reflux.—The volume ratio of halite to anhydrite in the Castile

formation as a whole is less than 1:1 (Adams, 1944, p. 1620) as compared with a volume ratio of sodium chloride to calcium sulphate in sea water of about 30:1. The volume of water that must have been evaporated to yield the volume of anhydrite contained in the Castile sediments was approximately 2,500 times the volume of the basin itself, as is discussed subsequently. Either incomplete evaporation of a single body of water or deposition and subsequent removal of the halite in a single volume of water is therefore an inadequate explanation of the scarcity of halite. It is necessary to account either for non-deposition of halite during a protracted period of continuous evaporation and replenishment or for subsequent removal of halite deposited with the anhydrite.

Although locally some halite and some anhydrite were removed from the top of the formation by the pre-Salado erosion, the perfect preservation of the delicate laminae in the anhydrite refutes the suggestion that halite was interbedded with the anhydrite but was subsequently removed.

The alternative to be followed may be stated in another way. It is necessary to account for cessation of evaporation when the surface layer of water reached the concentration at which halite precipitates, that is, when the specific gravity is about 1.21. Inasmuch as evaporation takes place only from the surface layer and inasmuch as the surface layer does not sink until its density equals that of the underlying brine, it follows that the specific gravity of the brine must not exceed 1.21 if deposition of halite is to be avoided. A specific gravity of 1.21 would have been exceeded early in Castile time, however, unless the dense brine could escape from the basin (Adams, 1944, p. 1620). Escape of the brine by percolation into the substrata would require permeable substrata and an outlet at lower altitude, that is, far below sea level. It seems more likely that the brine returned to the sea either by overflowing the barrier or by percolation through it. This theory is offered here as a modification of Ochsenius' bar theory and is termed the theory of *reflux*.[3]

The barrier.—If the theory set forth is correct, the Delaware Basin was connected to the sea by a channel through which new sea water entered the basin to replace the water lost by evaporation and by reflux and through which the reflux returned to the sea. In view of the small amount of clastic material deposited thereby, the volume of terrestrial water can be disregarded, and the volume of sea water entering the basin can be regarded as equal to the volume evaporated plus the volume that returned to the sea as reflux. The previously cited critical specific gravity of 1.21 is attained when about 90 per cent of sea water is evaporated. It follows that the reflux would have been about 10 per cent of the water that entered the basin. The ratio of the mass velocities of the entering sea water and the departing brine would then be 10:1.

The new water entered the basin as the surface layer, which extended down

[3] Adams had the opportunity of examining the first draft of this paper before he published and he courteously refrained from using more of the material than was necessary, and from stating the theory, lest he divert any credit to himself. This accounts for the similarity of treatment in the two papers.

to wave base, whereas the reflux was heavy brine of the underlying layer. If the linear velocity of the influx and reflux were equal the ratio of the cross-section area of the channel above wave base to that below wave base would likewise be 10:1. Depth to wave base is a fluctuating factor and its average value in Castile time is unknown, so the absolute height of the barrier cannot be determined.

Alternatively, if the barrier consisted of loose sand the reflux could pass out of the basin by percolation through the barrier. Such a permeable sand bar would not prevent reflux even though it extended up to wave base. Presumably it could not long persist above wave base.

Rate of evaporation.—The laminae in the anhydrite range from 0.2 mm. to 7.0 mm. in thickness and average 1.63 mm. in Gresham and McAlpine's core test hole Flood No. 1 in Culberson County, Texas (Udden, 1924, p. 353). On the reasonable assumption that the laminae represent annual layers or "varves," and on the basis of the average thickness of the laminae studied and the known thickness of the laminated anhydrite in this hole, Udden calculated the duration of Castile time as 306,000 years.

The area of the Delaware Basin is estimated as 10,000 square miles. The average thickness of the anhydrite in the Castile formation is 1,250 feet. The volume of anhydrite is calculated therefrom as roughly 350×10^{12} cubic feet. A factor of 10.9 cubic feet per ton is used to convert this figure to 32.5×10^{12} tons. Assuming that evaporation of sea water to about 10 per cent of its original volume yields 0.113 per cent anhydrite, deposition of the Castile anhydrite would have required evaporation of 28.75×10^{15} tons of sea water, equivalent to 928.5×10^{15} cubic feet before evaporation. Inasmuch as the area of the basin is only 283×10^{9} square feet, this volume of water would have filled the basin to a depth of 3,280,000 feet if it had all been present at one time. The evaporation of this volume of water to 11.2 per cent of its original volume would have yielded about the amount of halite present in the Castile formation, so it is unnecessary to make any additional allowance for halite. (Elsewhere the figure 10 per cent has been used for simplicity.)

It is assumed that 11.2 per cent of the 3,280,000 feet of sea water, or 370,000 feet, returned to the sea as reflux, and that 2,910,000 feet evaporated. Dividing this last figure by Udden's figure of 306,000 years for the duration of Castile time gives an average net rate of evaporation for the entire basin of $9\frac{1}{2}$ feet, or 114 inches, a year.

It may be suggested that a direct calculation of the amount of evaporation required to deposit an average annual thickness of 1.63 mm. (Udden's figure) of anhydrite should give the desired result. Such a computation, however, would not take into account such factors as the difference in concentration of the water of the surface layer at different points in the basin, difference in rate of evaporation at different points, the presence of nonlaminated anhydrite, and the effect of currents in the basin. If the "varves" are pictured as wedges or lenses the weakness of the method becomes obvious.

Original composition of calcium sulphate sediments.—According to the theories herein presented, at the beginning of Castile time the Delaware Basin contained normal sea water, but as evaporation proceeded while circulation was restricted by the barrier the salinity increased, and the more concentrated solution ponded behind the barrier. Soon the concentration throughout the basin reached the point of saturation with respect to calcium carbonate, and the thin basal calcareous layer of the Castile formation was deposited. Subsequently the concentration reached the point of saturation for calcium sulphate, and that substance was thereafter precipitated along with the additional calcium carbonate that continually entered the basin in the new sea water.

If the temperature exceeded 42°C. (107.6°F.) all the calcium sulphate was precipitated as anhydrite (Posnjak, 1938, p. 268). Such a temperature seems excessive, although not impossible. If the temperature was 30°C. (86°F.) the calcium sulphate was deposited as gypsum until the concentration of the brine was about 4.8 times that of normal sea water and the specific gravity was about 1.11 (Clarke, 1924, p. 220); thereafter it was precipitated as anhydrite (Posnjak, 1940, p. 565). This concentration would have been attained in slightly more than one one-thousandth of Castile time. In either case, virtually all the calcium sulphate was deposited as anhydrite if, as herein suggested, the concentration of the brine was maintained throughout Castile time at or near that at which sodium chloride begins to precipitate.

Any theory that attempts to show that the major part of the calcium sulphate was originally deposited as gypsum rather than anhydrite should include supporting evidence of a cause of dehydration, of a path for the water in leaving the formation, and of an ultimate destination for the water.

Locally and temporarily the concentration reached the point of saturation for sodium chloride, and halite was deposited. Such periods were relatively brief and may have resulted from temporary raising of the barrier, which would reduce the rate of reflux, or from temporary or local increase in the rate of evaporation.

The comparison of the laminae that characterize most of the anhydrite of the Castile formation with those of varved clay deposits has been interpreted as implying an alternation of periods of deposition and periods of non-deposition similar to that producing the varve markings in clay. That may be the correct explanation, but another possibility should be considered. It must be borne in mind that we are not dealing with isothermal evaporation. The temperature of the surface layer of water in the basin responded to seasonal changes in atmospheric temperature, and the solubility ratio of the calcium sulphate and calcium carbonate likewise varied. The temperature of the underlying brine may have remained virtually constant, but the brine was already saturated with respect to both compounds, so that particles of either substance settling through the brine were unaffected by it.

SUMMARY

It is suggested that in a basin such as the Delaware Basin, enclosed on all

sides but connected to the open sea by a restricted channel, the water becomes differentiated into an underlying concentrated brine of uniform density, which lies below wave base and is ponded behind the barrier, and a surface layer of somewhat less average density, the water of this layer being normal sea water near the entrance of the basin. In Castile time a portion of the underlying brine flowed continuously from the Delaware Basin to the open sea as reflux, and new sea water entered the basin continuously to offset the loss by reflux and evaporation. The more soluble salts remained in solution and passed out of the basin in the reflux. The less soluble salts were precipitated.

The Castile formation consists principally of anhydrite. The scarcity of clastic material indicates a scarcity of terrestrial water, which is consistent with the computed rate of evaporation of 114 inches a year throughout Castile time. Hence only a small portion of the precipitated sediments can be attributed to a terrestrial source. The preponderance of anhydrite indicates that the ratio of influx to reflux was about 10:1, as a ratio of, say, 12:1 would have resulted in deposition of more halite than anhydrite.

If the barrier at the entrance to the basin had been continuously maintained at wave base and if it had been impermeable there would have been no reflux of the underlying brine as such, so it is suggested that the top of the barrier lay somewhat below average wave base or else that the barrier was permeable.

If, in accordance with the theories just stated, the salinity of the Castile sea within the Delaware Basin was near the point of saturation with respect to sodium chloride throughout Castile time, the calcium sulphate was deposited as anhydrite rather than gypsum.

It is suggested that the characteristic lamination of the anhydrite of the Castile formation may be ascribed to seasonal variations in temperature and accompanying variations in relative solubility of anhydrite and calcite, rather than to cyclical interruptions in deposition.

The theory of reflux is essentially a modification of Ochsenius' bar theory designed to explain the deposition of the Castile sediments and other similar deposits.

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AERIAL PHOTOGRAPHS IN STRUCTURAL MAPPING OF SEDIMENTARY FORMATIONS[1]

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ABSTRACT

Factors that control the use of aerial photographs in structural mapping are discussed; the anticipated horizontal and vertical photogrammetric precision is indicated; and geomorphic and structural relationships are correlated with photogrammetric procedures that most economically produce structural maps of various tolerances.

The usefulness of aerial photographs in geologic field work has been recognized for many years. Lee's study (1922), "The Face of the Earth as Seen from the Air," was the first of geologic and geographic significance. Since then, geologic literature has contained several papers and books devoted largely to photographic interpretation; among the more comprehensive are those of Loel (1938), Eardley (1941), Smith (1943), and Levings (1944). In these the applications of aerial photographs to geologic problems were considered, the use and methods of interpretation discussed, and the numerous advantages pointed out. In addition to these treatises, there are many more or less casual references to the use of aerial photographs; the bibliography compiled by Cobb (1943) contains the results of a thorough search of foreign as well as domestic literature.

Photogrammetric processes received increased attention after World War I and since the 1930's have been under lively discussion, a fact in part responsible for the improvement of photogrammetric equipment and techniques. The books of Talley (1938) and Bagley (1941), the manual by McCurdy (1940), and War Department Technical Manuals 5–230–Topographic Drafting and 5–240–Aerial Photography include the phases likely to be of importance to the geologist.

In spite of this considerable related literature, relatively little has been published on the application of photogrammetric techniques to specific structural mapping problems. Eardley (1941, pp. 170–75), Smith (1943, pp. 201, 257–62), Desjardins (1943a), and Desjardins and Hower (1938) have discussed briefly the use of photographs as plane-table sheets, transfer of contacts from photographs to topographic maps, dip and strike calculations, and methods of structural contouring from contacts and contours on aerial photographs. They have not, however, considered adequately the theoretical limitations of photogrammetric processes or the difficulties and inaccuracies that may result from inherent distortions present in all photographs. Moreover, these methods are neither readily applicable to, nor desirable for, many field relationships.

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FACTORS CONTROLLING APPLICATION

In general, factors that control the various methods of application are: (1) character of photography, (2) accuracy required, (3) availability and reliability of ground control, (4) character of topography, (5) type of structure, (6) character of vegetal, soil and mantle cover, and (7) accessibility of area.

Obviously, some of these factors will assume greater significance in certain areas than in others. For example, if the vegetal and soil cover should be that frequently found in the tropics—an unbroken tree canopy hiding a thick residual soil—photographs would be of little use except for evaluating accessibility unless the geomorphic development or vegetal-soil relationships were amenable to structural analysis. Moreover, it is evident that a proper diagnosis of the photogrammetric methods applicable to the various geologic-photographic relationships is difficult, if the anticipated photogrammetric precision cannot be correlated with the desired geologic tolerance.

PHOTOGRAMMETRIC PRECISION

The precision attainable by any photogrammetric process is dependent largely on the quality of photography and the ground control available. Although poor definition, insufficient sidelap, clouds, *et cetera* bear materially on the quality of photography, distortion is ordinarily the critical factor in so far as horizontal and vertical photogrammetric control is concerned. An undistorted vertical photograph is, of course, a true perspective projection; unfortunately, a photograph without distortion has probably not yet been taken. This photographic distortion results from lens aberrations, differential expansion and contraction of negative and positive stocks, and tilt (deviation of the optical axis of the camera from vertical).

The first two distortional elements are ordinarily not critical. Most lenses used in aerial photography are of high quality; bench tests readily indicate the amount of distortion as well as the resolving power. It is noteworthy, however, that distortion is usually greater in wide-angle short focal-length lenses than in the longer cones. Moreover, topographic film support, either acetate or nitrate, has excellent dimensional characteristics (Clark, 1944). Although considerable expansion and contraction take place with development and changes in humidity, these dimensional variations are nearly uniaxial (maximum biaxial variation less than 0.08 per cent), which fact does not greatly affect photogrammetric procedure.

Ordinary photographic papers, however, are unsatisfactory for either planimetry or height finding because of the poor dimensional characteristics. Only waterproof or double-weight matte paper should be used, and for best results it should be air dried with controlled humidity. During the war it was found that even the best papers considerably hampered mapping because of the lack of humidity control in forward area laboratories.

Tilt is usually the worst detriment. Although most contracts specify that a

high percentage of exposures must be within 3° of vertical, almost every exposure has some tilt and not infrequently a few may be considerably in excess of 3°. The error introduced by 3° tilt does not materially affect the accuracy of horizontal photogrammetric control except in areas of large elevation differentials. Uncorrected 3° tilt can, however, cause discrepancies in vertical control of such magnitude that the work is rendered worthless. For example, a 9×9-inch print at 1.20,000 covers 15,000 feet in each direction: 3° tilt causes an error in elevation from one side to the other of almost 800 feet.

HORIZONTAL PHOTOGRAMMETRIC CONTROL

Since a photograph is a perspective projection rather than an orthographic projection and since there are numerous scale variables, some system of horizontal control must be used to eliminate the resultant inaccuracies. For the geologist the simplest and best method of maintaining this control is the radial plot or, preferably, the slotted templet or radial intersector adaptation thereof. This method is described at length in all photogrammetric texts as well as in several texts devoted to photographic interpretation. It is a system of photographic triangulation that, from a few ground-control points, permits establishment of a dense network of horizontal photographic control points which may be used as origins for compilation of planimetric detail. The system is based on the premise that the horizontal angles of a photograph are true when measured about the nadir point (point at which a vertical ray through the perspective center of the camera lens pierces the plane of the photograph). Although a radial plot does not correct absolutely the distortions discussed in the preceding paragraphs, it usually permits selection of severely tilted photographs and removes major scalar variations that result from changes in flight altitude, elevation of terrain, and topographic displacement, thus maintaining a near constant scale over a large photographic assemblage.

Since a photograph shows the position of objects as projected through the lens, the removal of topographic or relief displacement is essential. It is evident from Figure 1 that relief is reflected on the photograph as radial displacement away from or toward the nadir point. Thus, point A, the nadir point, is always in its true geographic position, while point B, higher than the nadir point, is displaced away from it, and, conversely, point C toward it. The amount of displacement depends upon the flight altitude, focal length of the lens, and the distance from the nadir point. Since, however, lineal measurements are not made in the radial plot, if these points of varying elevation and displacement are established by resection from two or more nadir points, the points theoretically occupy their true geographic positions.

In the foregoing discussion the effect of tilt has not been considered. While topographic displacement is radial from the nadir point, angular values are true from the isocenter in a tilted photograph. Figure 2 shows the relationship of the principal point, isocenter, and nadir point: the principal point is found by the

prolongation of the optical axis (principal ray), the nadir point by the plumb line, and the isocenter by the bisectrix of the two; all three points are coincident only in a true vertical. Unfortunately, the precise determination of the isocenter and nadir point not only requires extensive ground control but also onerous calculations. Kowalczyk, Fish, and Dill (1944, pp. 363–65) have shown, however, that where there is no relief the error in the radial assumption from 3° tilt when the principal point is used rather than the nadir point can be only 0.00412 inch at

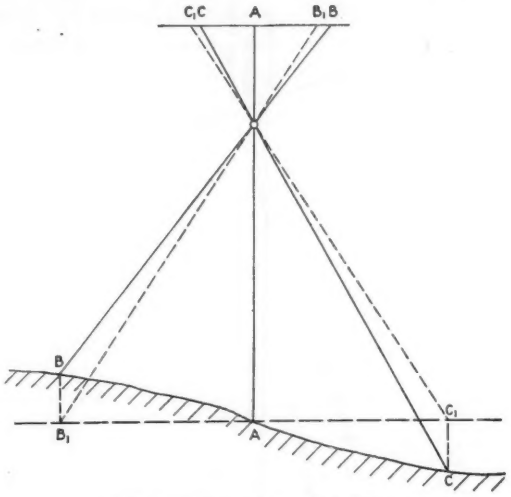

FIG. 1.—Topographic displacement.

6 inches from the principal point; with a 2,000-foot elevation differential, flight altitude 10,000 feet, and focal length 8.25 inches, the combined error may be 0.0906 inch.

The directional error to be anticipated in establishing rays to the various points in the radial plot as well as with other methods of surveying has been summarized by Reading (1944, pp. 11–12). Although lens aberration and negative and positive variables play an important part, he concludes that with care and good equipment the directional error may be as low as one minute of arc or 0.0018 inch, at 6 inches from the nadir point, a discrepancy less than one-eighth ordinary graphic tolerance.

While these theoretical considerations indicate that the radial plot is highly satisfactory, it remained for the excellent test assemblages of the Department of Agriculture to determine the practical accuracy that could be anticipated as well as the best methods of incorporating ground control. Kelsh (1940) describes the results of tests of Beltsville, Maryland, Carter and Murray counties, Oklahoma, and Bird and Caney watersheds in Kansas and Oklahoma. The Beltsville test

included a rectangular area of 155 square miles with 273 ground control points and relief of about 200 feet. The area was covered by 233 9×9-inch photographs at 1/12,000 and the slotted-templet adaptation of the radial plot was used. Seven assemblages, each incorporating different systems of ground control, were made with great care. With one control point in each corner of the assembly, extremely scant control, the average error of absolute position of all ground-control points was 43 feet and the maximum error 125 feet. With eight well

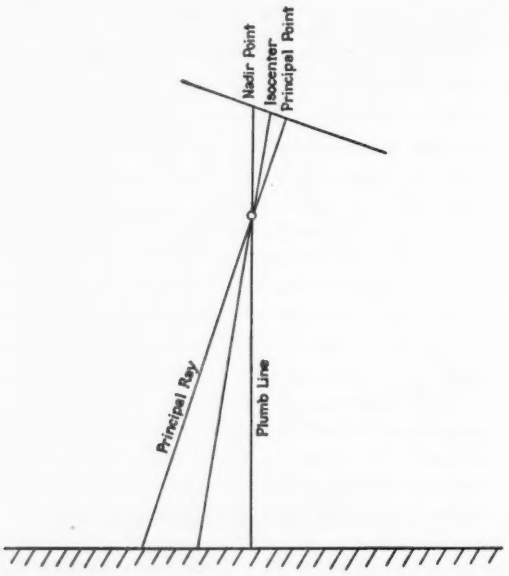

FIG. 2.—Relationship of principal point, nadir point, and isocenter.

distributed ground-control points, the entire assemblage was rigid and the average error of all positions recovered dropped to 18 feet, the maximum error 90 feet. With additional ground control, the gain in accuracy was no longer commensurate with the added control. The Bird and Caney watersheds project was the largest tested; 2,700 templets were required to cover the 4,400 square miles. Ground control was used only along the perimeter; the distance between control along flights averaged 93 miles with 108 templets and across flights 51 miles and 25 flights. Of the 192 ground-control points checked, the maximum error was 145 feet and the average 45 feet. Kelsh concludes that the slotted-templet method is satisfactory for "making a planimetric map of fair accuracy of any portion of the United States, using only the existing ground control" and for maps made from photographs at 1/20,000, "the average error in feet should not exceed the average number of photographs between control, and the maximum error should not exceed three times the average error."

VERTICAL PHOTOGRAMMETRIC CONTROL

Unfortunately, vertical photogrammetric control is neither as simple, nor as reliable, as horizontal control. Although tilt and the other distortions are detrimental to horizontal control, they are an anathema to accurate elevation determinations. Moreover, methods of correction are not only time-consuming and require extensive ground control, but often the results are unwittingly inaccurate.

The theory and technique of height finding are not difficult; excellent treatment is found in the various photogrammetry and photo interpretation texts. The parallax equation, the basis of simple elevation determination, is ordinarily written $\Delta p = (\Delta h B_m / H - h)$: Δp = the parallactic differential; Δh = the height of

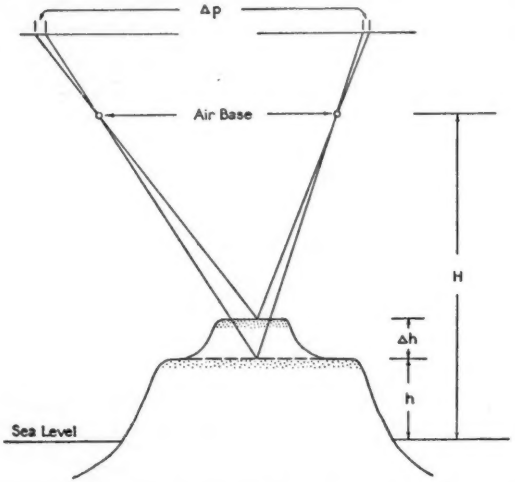

FIG. 3.—Relationship of parallax differentials and elevation variables as determined in parallax equation.

the object measured; h = elevation above sea-level; B_m = the stereoscopic base (air base) in millimeters; and H = the flight altitude (Fig. 3). Obviously, the equation is not a linear function; with a stereoscopic base of 100 millimeters and flight altitude of 10,000 feet, an elevation differential of 100 feet produces 1.005 millimeters parallax, while at 20,000 feet only 0.501 mm. Thus since parallactic differentials can be read with ease to 0.05 mm., elevations can be determined to ± 5 feet at 10,000 feet and to ± 10 feet at 20,000 feet, the usual altitude range of commercial photography.

This precision, however, is possible only if all effects of distortion that result from tilt, differential positive and negative expansion and contraction, lens aberration, and variation in flight altitude have been removed. Construction of a datum plane correction graph (Nowicki, pp. 470–76) is the simplest method of removal. Unfortunately, as shown by Figures 4 and 5 from Nowicki's paper, ac-

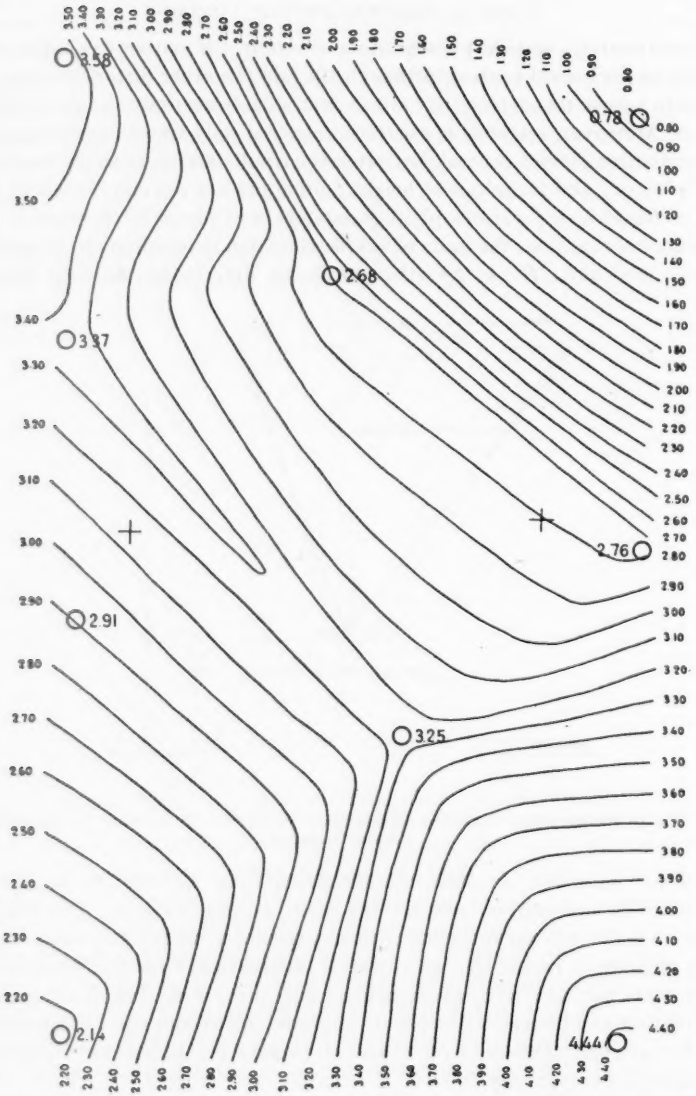

FIG. 4.—Datum-plane correction graph based on nine ground elevations. (After Nowicki, *Manual of Photogrammetry*, p. 472; permission granted by American Society of Photogrammetry.)

cumulative distortion is by no means regular enough that three spot elevations suffice for determination of strike and gradient; at least eight symmetrically spaced elevations are required in the area on which stereopsis obtains. Even then, referring again to Figures 4 and 5, there may be considerable residual distortion. In Figure 5, twelve additional control points have been introduced; these reveal a discrepancy of approximately 0.8 mm. in the center, an error of more than 150 feet if the flight were 20,000 above terrane.

Obviously, the large amount of vertical control required presents a considerable problem. When a reconnaissance survey has been made or the area mapped topographically, bench-marks may be transferred to the photographs; advance sheets should be used when possible because they ordinarily carry more secondary control. In spite of the fact that a stereopair from 9×9-inch prints at 1/20,000 covers about 5 square miles, eight bench marks are rarely available. The writer has found through field checks, however, that control may be supplemented by elevation estimates along streams. Although the resultant error depends largely on the accuracy of the map, ordinarily these assumed elevations are within the tolerance of a 50-foot contour interval.

In regions that have not been mapped the only recourse (Desjardins, 1943b, Nugent, 1945) lies in an analysis of the geomorphic elements, particularly streams, and in an assumption of a stream gradient. While recourse to such practice is only an expedient at best, experience in the past war, during which it was necessary to map many islands with sea-level as the only control, has shown that such methods permit a fairly reliable regional presentation.

Thus, the photogrammetric precision possible in the extension of horizontal control is easily within the limits required for all excepting the most precise type of structural mapping. The accuracy of vertical control, however, depends on the amount of ground control available or on the judgment and ability of the geologist.

SCALE OF PHOTOGRAPHY

The optimum photographic scale, like each mapping problem, is unique in itself; obviously resistant formations outcropping in a semi-arid region can easily be traced on small-scale photographs, while weak members in a humid region may not be discernible on large-scale photographs. In a recent paper Melton (1945, pp. 1764–65) has concluded that photography suitable for topographic mapping is commonly unsuitable for geologic interpretation because a scale of 1/20,000, a common mapping scale, does not afford sufficient detail. He recommends 1/8,000 as generally adequate. While it is true that large scales may be desirable for igneous and metamorphic areas, these scales should be avoided for structural mapping of sediments unless absolutely necessary because of the enormous increase in photogrammetric labor. First, if outcrops and bedding are so inconspicuous that they are not discernible at medium scales (1/15,000–1/40,000), the value of structural mapping by photogrammetric methods is questionable from the geologic viewpoint. Second, since a print at 1/8,000 covers only 1/16

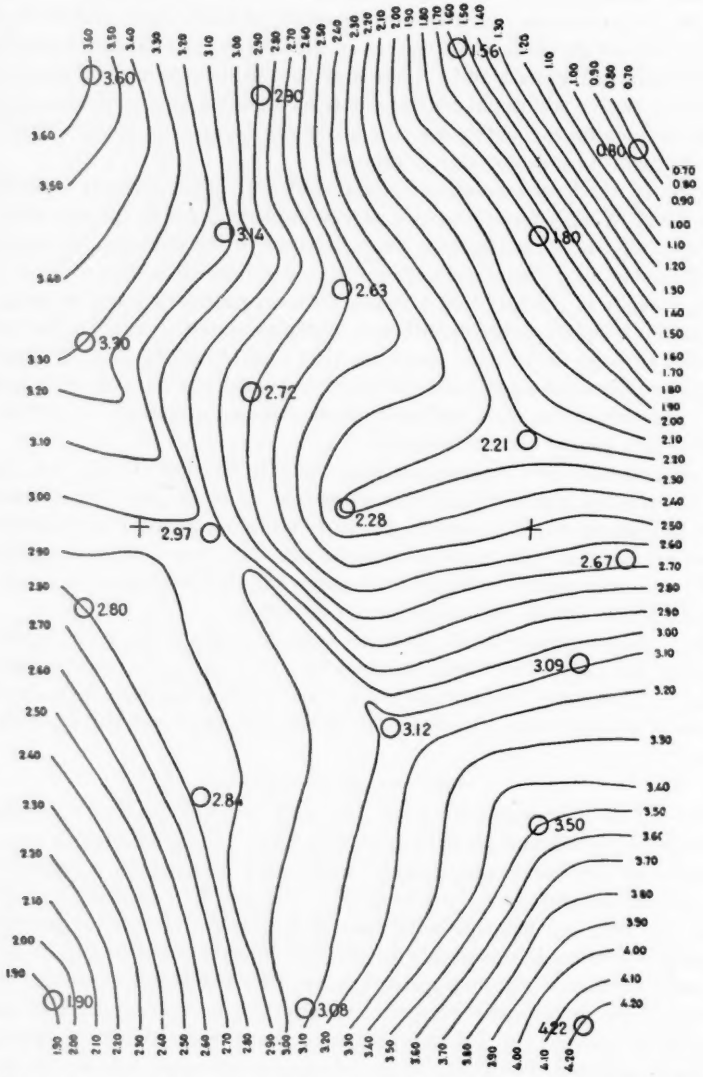

FIG. 5.—Datum-plane correction graph for same stereopair with 12 ground elevations. (After Nowicki *Manual of Photogrammetry*, p. 473; permission granted by American Society of Photogrammetry.)

the area of a print at 1/32,000, the increased work and cost may assume prohibitive proportions photogrammetrically. Third, the density of vertical ground control required increases geometrically.

Medium-scale photographs have been found satisfactory for most structural mapping and field checks in which geologic-photographic relations were amenable to such techniques; the writer has mapped topographically considerable area from vertical prints at scales of 1/70,000 that would have been adequate for structural mapping of an area of bold outcrops; the largest commercial geologic project utilized 1/40,000 almost exclusively; 1/31,680 has proved excellent for regions of good outcrops.

ORDER OF PHOTOGRAMMETRIC PROCEDURE

Although it is not the province of this paper to undertake a discussion of photographic interpretation, the logical order of interpretative and photogrammetric treatment is worthy of note. While one or more of the steps may be omitted with certain methods, such omissions merely remove the step from the total procedure rather than change the order.

Before any photogrammetric process is undertaken the prints should be examined stereoscopically by a geologist skilled in photographic interpretation, and preferably familiar with the region, to determine whether the lithologic and vegetal character permits structural mapping by photogrammetric means. In some instances this fact may be ascertained by a cursory examination, in others it may be necessary to delineate outcrops after the section has been checked in the field. Where the geologic-photographic relationships are satisfactory, a relationship not present in 50 per cent of the cases, the prints may be prepared for a radial plot or key beds completely delineated. If the geologist participates in the radial plot, it is perhaps better to establish horizontal control first, thereby permitting greater familiarization with the area. After horizontal control has been established and planimetry and outcrops compiled on the master sheet,[3] vertical control for the structural and topographic analysis is obtained, a critical procedure that varies with the several methods of mapping. Lastly, the structural map is constructed on the controlled overlay from spot elevations on the contacts or from intersection of contours and contacts.

METHODS OF STRUCTURAL MAPPING

Mapped areas of low relief and low dips.—When the map is considered reliable, the scale adequate, and the structure is to be mapped on a 50-foot, or larger, interval, little is gained by establishment of either horizontal or vertical photogrammetric control; since areas of low relief are usually mapped with a contour interval of 20 feet or less, the refinement possible photogrammetrically, if any, is negligible. Moreover, the tolerance of a 20-foot contour is proportionately less

[3] If a controlled mosaic at a usable scale is available and if the definition of planimetry and outcrops is satisfactory, the mosaic may be used as a base, thereby eliminating establishment of horizontal control photogrammetrically and compilation of planimetry.

than that of a 50- or 100-foot structural contour. The method, therefore, that requires the least effort entails delineation of outcrops and transfer to the map, a procedure that involves a perspective projection and one which approaches an orthographic projection for small areas. The transfer may be made in a number of ways: if no change in scale is required, a light table will serve; when reduction or enlargement is necessary, any camera lucida that possesses the range may be used; a photographic or pantographic system may be adopted; or, if the detail of the photograph is easily identified on the map, the transfer may be made by sketching.

Since the outcrop of several formations must ordinarily be delineated to map any considerable area of low relief, the vertical intervals between formations are required before the structural map can be referred to a single datum. Although the most accurate map will result from measurement of sections in the field, intervals may be determined by extrapolating dips of successive formations in any area of relatively constant dip; difficulties presented by unconformities are obvious. After transfer and determination of intervals the structural contours are constructed in the usual manner.

When the scale of the topographic map is inadequate, it is necessary to have the base enlarged or to lay a radial plot to the expanded horizontal map control and compile the outcrops and essential planimetry. In the latter case, since the relief is not great, time-consuming height finding may be avoided by transferring spot elevations and roughing in the contour lines. When desirable, contours may be drawn with refinement by incorporating the detail of the spatial model provided by the photographs. Formational intervals and the structural map are handled as previously indicated.

Mapped areas of considerable relief and low dips.—While it is commonly possible to recognize contacts on topographic maps, there is no question that contacts can be more easily and positively identified on aerial photographs, as well as more accurately located. Although structural contours may be constructed from transfer of contacts to the map, obviously the tolerance demanded of a 50-foot or 100-foot structural contour can not be maintained where slopes are steep and valleys deep except where the topography is such that outcrop elevations can be accurately estimated by incorporating the detail of the spatial model with that of the map. In this case structural mapping parallels that of the preceding section.

Where this is impossible the planimetry is compiled and the formations chosen for structural control are delineated and compiled after the radial plot has been laid to the expanded map control. In easily accessible areas the greatest saving in time and most reliable map will result from choosing key outcrops and critical points in the office and securing altimeter elevations on these points. It has been established that photogrammetric horizontal control is satisfactory for most geologic maps; therefore, the precision of the structural map is dependent upon the accuracy of the altimeter elevations. These determinations should be well within

the limits permitted by a 50-foot or 100-foot structural contour. Kissam's report (1945) on precision altimetry stated that of 100 stations checked over an area 20 miles square the average error was 1.76 feet and the maximum 6.7 feet with the two-base methods, and the average 2.08 feet and the maximum 11.6 feet with the single-base method. Since precision of this order is not required for most structural mapping, some of the refinements introduced in the foregoing tests may be eliminated.

Again, it is preferable to determine intervals between formations used for structural control from measured sections. If, however, this should be impracticable, intervals can usually be established by stereocomparator (height finder) in deep valleys where the formations may outcrop in close proximity. If such favorable sites are unavailable, dips may be extrapolated.

Although maximum accuracy and minimum photogrammetric procedure result from elevation determinations on the outcrop, much strenuous field work can be eliminated by taking elevations only along streams in a rugged region where movement is difficult. These elevations should be taken at easily recognized confluences, bends, *et cetera*, and should be as near good outcrops as possible. Moreover, since a datum-plane correction graph must be constructed, at least 8, and preferably more, well spaced elevations must be taken per stereopair. A stereocomparator is used for construction of the datum-plane correction graph and for determination of elevations on the outcrop. With this system two additional factors are introduced that may produce errors: (1) the inaccuracies, previously discussed, attendant with determination of parallactic values, and (2) the error that results from residual distortion. Since, however, the best outcrops are usually found in valleys and because of the proximity of elevations, this method ordinarily yields good results. Obviously, if elevations cannot be easily established along streams, determinations may be made anywhere so long as the distribution is satisfactory for the construction of a reliable datum-plane correction graph.

Sometimes, because of inaccessibility or inconvenience, it may be necessary to extend a structural map or map an area without a ground check. Under these circumstances the radial plot, outcrop delineation, and compilation are effected as previously. Bench marks are transferred to the photographs and, where adequate, a correction graph is constructed and outcrop elevations calculated. Where the benches are inadequate, however, spot elevations are assumed on the map and transferred to the prints. Obviously, an estimate is more accurate along a stream than elsewhere; moreover, elevations should be picked as near good outcrops as possible, another reason for using the drainage system. While this method is a practical expedient, in addition to errors introduced by the limitations of parallactic determinations and parallactic variations from residual distortion, errors that result from misplaced contour lines and faulty interpolations must be considered. Although it is difficult to weigh these variables, ordinarily the larger

errors result from contour inaccuracies and residual distortion. Intervals may be calculated photogrammetrically and the map constructed from elevations determined on the outcrop.

A very rugged, relatively inaccessible area that had been mapped by the United States Geological Survey by plane table in the 1930's was chosen for a test of this method. About 20 square miles were mapped in which more than half of the elevation control was assumed. Of the elevations recovered by altimeter, approximately three-fourths were within the limits permitted by a 50-foot structural contour. It is very doubtful that this precision could be maintained where the drainage system is poorly developed.

Mapped areas of high dips.—When the scale and contour interval are adequate and the geologic photographic relationships satisfactory, photogrammetric procedure is simplified and field work minimized. Formations used for structural control are carefully delineated and transferred to the map. In areas of considerable relief and comparatively low dips it may be possible to calculate dips and strikes photogrammetrically by determinations of elevations on the outcrop, usually after construction of a datum-plane correction graph. In areas of bold geomorphic development determinations may be made on dip slopes, a procedure described by Desjardins (1943a) which entails calculation of two or three spot elevations and their horizontal positions. Although dips determined by the foregoing methods are usually not as accurate as by those described previously, the structural contours constructed from these determinations and their projections in conjunction with careful stereoscopic study will satisfactorily portray the axes and configuration of the structural elements.

Structural mapping of fair accuracy is also possible when dips can not be determined photogrammetrically. In this method dips are calculated from the trigonometric relationship of outcrop width and terrain variation after formational thicknesses have been determined, preferably from measured sections. A graphic solution is usually simplest, especially when an average is sought from several dip determinations.

When the scale of the topographic map is unsatisfactory, a radial plot is laid to the expanded map control and the formations are compiled directly. If vertical control is adequate, mapping may proceed as previously indicated. If not, control must be augmented photogrammetrically or from field observations.

Accessible areas in which neither horizontal nor vertical control is available.—Under these conditions structural mapping with aerial photographs is relatively simple. After preliminary evaluations have been made, the horizontal control program is planned. When the area to be mapped is relatively small, a loose triangulation net will suffice. When this is unfeasible or the area extensive, horizontal control may be obtained by prismatic astrolabe or similar instrument. These control stations are incorporated in the routine radial plot. After compilation of planimetry and outcrops, vertical control may be obtained by altimeter if the contour interval is to be 50 feet or more. Again these elevations may be on the outcrop or they may be spaced for construction of a datum-plane correction

graph. Intervals are preferably determined from measured sections. Where dips are high, the techniques discussed in the preceding section may be used. The accuracy of the map may be estimated from the density and precision of the horizontal and vertical ground control. Obviously, it is unnecessary to construct a topographic map.

Non-accessible areas in which neither horizontal nor vertical control is available. —When such an area is amenable to structural mapping photogrammetrically, with favorable topographic development it is possible to derive a satisfactory regional map. Although an estimate of tolerances is difficult, the map will usually be superior to a reconnaissance survey and may incorporate as much detail as the geologic-photographic relationships permit.

Approximate horizontal control is established by an uncontrolled radial plot. Although scalar variations are undetectable, if tilt is not excessive and the flight altitude constant, the variations that result from topographic displacement and terrain elevation will be largely removed. Waterways furnish the best check possible; sea, level or large lakes are ideal. For example, if the area mapped is bounded by two major streams, the elevation of which may be considered similar from geomorphic and geographic relationships, if the radial plot control points at both streams exhibit similar scalar variations from the photographic points, and if the flight altitude is constant, the scale of the entire assemblage may be assumed relatively constant.

Tilt is usually the major problem in elevation determinations. Since no vertical control is available, the geologist must again appeal to geomorphic evidence. After a thorough analysis, especially as concerns stream development and profiles, the gradient of the major rivers and tributaries must be estimated and spot elevations assumed at important confluences and critical points. Obviously the accuracy of the estimates is dependent upon the geomorphic development; traversal by mature or old streams enables close estimates while that by youthful streams presents many difficulties. (The absolute radio altimeters of low-flying aircraft may be helpful in approximating the elevation of various terrane features.) The datum-plane correction graph, outcrop elevations, formation intervals and the structural map are calculated and constructed as before. Again, time-consuming topographic mapping is eliminated.

While the writer has not used this system of control in structural mapping, he has participated in its satisfactory use in mapping topographically several thousands of square miles in the South Pacific. The smallest photographic scale that permits delineation of outcrops is best for such mapping because each print covers more area and, concomitantly, includes more streams (Nugent, 1945, p. 164).

Areas in which structural contour interval must be 25 feet or less.— Because of the errors inherent in the determination of elevations by photogrammetric or altimetric methods, the foregoing applications are ordinarily unsatisfactory for structural mapping when the tolerance is so small; although precise plotting instruments are utilized in topographic mapping at these intervals, the geologist

usually has neither the instrument nor the skill required for operation. Moreover, these small intervals usually require relatively low altitude photography with the concomitant geometric increase in the number of spatial models and ground control necessary unless abnormally short focal lengths are used.

Although reversion to plane-table methods is necessary, aerial photographs still facilitate structural mapping appreciably. In addition to the advantages obtained from stereoscopic regional study, accessibility evaluation, and outcrop delineation, the photographs may be used in direct conjunction with instrument work (Eardley, 1941, pp. 170–75; Smith, 1943, pp. 201, 257–63). Although enlarged prints have been used as plane-table sheets, little is gained unless the area has very little relief or the print has been ratio-enlarged to radial plot control because topographic displacement is radial only from the nadir point. In fact, the descrepant angles that result from occupying a station other than the nadir point in rugged terrane or from excessive tilt may prove highly detrimental. The better, and unusually accurate, method involves the use of a planimetric base map as a plane-table sheet. This base is controlled by radial plot and contains outcrops, roads, trails, and fences, as well as all landmarks that might aid the instrumentman. Thus, most plane-table traversing is eliminated and elevations may be quickly determined after critical outcrops have been chosen by stereoscopic examination.[4] In either case construction of the structural map follows the usual pattern.

Oblique aerial photographs.—Although oblique photographs may be of limited use in structural mapping by photogrammetric methods, obliques should ordinarily be used only in the reconnaissance sense because the photogrammetric precision is much less than with verticals. In recent years obliques have found widespread use in planimetric mapping at reconnaissance scales because of the area covered by each print and because the specifications for such flying are usually less rigorous than for vertical mapping. These advantages, however, do not obtain from the geologist's viewpoint: the small scale of such photography is usually undesirable for complete geologic evaluation; construction of a map that approaches the order of accuracy possible by plane-table methods requires medium-scale vertical photography and careful flying. Moreover, oblique mapping usually requires more equipment and the photogrammetric procedure is more involved.

Although obliques may be taken at any angle, ordinarily high obliques (those that include the horizon) are used. Obviously, the scale must change rapidly; with the trimetrogon system the scale of the oblique photographs is approximately half as much at the center of the photograph as at the lower edge. Further, when such photography is used in regions of considerable relief, dead areas (lacunae) occur frequently from topographic defilade.

Oblique photography was first used extensively by the Canadian Government

[4] In very rugged terrane where plane-table triangulation is necessary, a photograph or mosaic may be used for orientation, after which vertical angles may be determined instrumentally and distances photogrammetrically.

in mapping areas of small relief at a scale of 1 inch = 4 miles. This "Canadian system" involves rectification of each oblique by means of perspective grids and establishment of azimuth lines (*Canada Topog. Survey Bull. 62*). The chief use geologically of such photography is largely in regional studies, planning, and delineation of outcrops in the foreground. Where structural mapping is required, horizontal control is obtained from superposition of the outcrops on the base derived by rectification of the photographs and vertical control by altimeter elevations on the outcrop.

The trimetrogon system of mapping developed by the United States Geological Survey and the United States Army Air Forces is similar in theory to the Canadian system excepting that horizon-to-horizon coverage is obtained by operation of one vertical and two oblique cameras simultaneously (United States Army Air Forces). Because of the area covered per run and the ease of photogrammetric development, trimetrogon mapping is the most rapid of the reconnaissance type. The ultimate scales, however, are usually of the same order as with the Canadian system and the use geologically is similar. If difficulty is experienced in the use of trimetrogon obliques, a method of restitution has been developed that gives fair definition out to the centers of the prints as well as considerable enlargement.

Other methods of high oblique photography provide photographs with characteristics similar to those of the trimetrogon system. The use of low obliques (those that do not include the horizon) is also similar, except that more ground control is required.

Although elevations are not determined photogrammetrically in the preceding oblique systems, they may be calculated under certain conditions mathematically by iconography, or by multiplex. These operations, however, fall within the photogrammetrist's province; moreover, the results are frequently of less precision than those required for most structural mapping. While horizontal control may be bridged satisfactorily for considerable distances, tilt and other variables can introduce critical scalar and azimuth discrepancies that are undetectable unless there is a relatively dense network of fixes.

CONCLUSIONS

There is no question that the proper use of aerial photographs where the geologic-photographic relationships are favorable can produce structural maps of satisfactory precision more rapidly and economically than any other method. Although the disparities of structural and topographic mapping are well recognized, the similarity of field routine and physical conditions lends significance to engineering data. In the Tennessee Valley project an analysis of accuracy and cost was maintained on six systems of topographic mapping; three used precise optical plotting instruments, and three plane-table methods with enlarged aerial photographs or planimetric maps as plane-table sheets. Whitmore (1941) observes "as to the comparative costs of plane-table vs. plotting instrument techniques, it can be stated as a positive fact . . . that ground survey plane-table costs for 40-foot

and 20-foot intervals could not begin to compare favorably with the cost of maps produced by the stereoscopic-plotting instruments, always assuming the same accuracy," and suggests that in areas of little relief "the operator of the plotting instruments draw the complete manuscript map—planimetry, contours, drainage" and leave for "the topographer who will handle the field inspection and completion the job of completing the contours" rather than increase costs by securing the low-altitude, large-scale coverage required for small contour intervals. Obviously, because of the liberal tolerance of most structural contour intervals, altimeter and stereocomparator elevations may be substituted for elevations determined by plane-table and precise stereoscopic plotting instruments, a fact that eliminates most of the onerous photogrammetric and field routine. The ease of horizontal control and compilation of planimetry provided by radial plot makes comparison with orthodox plane-table techniques difficult.

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GEOLOGICAL NOTES

SUBNORMAL RESERVOIR SATURATION, SOUTH MAYES FIELD, CHAMBERS COUNTY, TEXAS[1]

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Certain facts regarding exceptional reservoir conditions were brought to light by the drilling of the Cox and Hamon's Mayes White No. 1, Chambers County, Texas. These are of such interest that a brief note describing them should be of value to men working with problems of this type. It is admitted that the theories accompanying this presentation of facts are controversial but they are advanced with the thought that broader consideration may lead to clarification.

The South Mayes field is located in west-central Chambers County, in the north part of a sector of the coast where widespread faulting is a dominant structural feature. Strike faults, dipping coastward with major throw, extend across Chambers County, from the northeast corner, southwestward into Galveston Bay, and these, combined with cross-faults, are an important structural factor in forming closure for numerous large oil and gas fields. It is in character with the structural environment, therefore, that accumulation at South Mayes should occur in a series of fault blocks. Two gas wells were completed in one fault block in 1944 and 1945 and the Humble Oil and Refining Company completed an oil well in a separate block on the southwest, in 1946. This last test, the Wallis No. 1, found gas in the first Frio sand at about 9,075 feet. The second sand, at 9,176 to 9,212 feet, was found to contain gas, oil, and water, with a 10-foot oil column at 9,192–9,202 feet. A third sand at 9,904–9,929 feet contained gas and distillate. The well was completed as a high-ratio oil producer in the second sand.

Information available after the completion of the Wallis No. 1 suggested the presence of an undeveloped fault block immediately east of this well. The Wallis No. 1 cut a 90-foot fault in the section between the first Frio gas sand and the Wallis oil sand. The trend of this fault is probably slightly north of west and it is assumed that it dips east, although the data on which this assumption is founded are not entirely satisfactory. Based on structural factors furnished by drilling and by seismic study, an east-west fault is placed across the area, cutting the Frio at a point about 2,000 feet north of the Wallis No. 1 and trending eastward, south of the two gas wells already mentioned. This fault dips coastward with a displacement of about 250 feet. Since the general dip of the beds on this part of the Coast is south-southeast, the contours rising north within the L-shaped sector, formed by the 90-foot Wallis fault and the major east-west fault, create the undeveloped trap in question.

[1] Manuscript received, February 5, 1947.

[2] Consulting geologist. Data submitted with the approval of Cox and Hamon, Dallas, Texas.

In August, 1946, Cox and Hamon spudded their Mayes White No. 1 at a point 2,100 feet due east of the Humble-Wallis No. 1. The location was made near the south side of the indicated trap because of uncertainty about the exact position of the main east-west fault. This test encountered the Frio at 9,150 feet, 100 feet lower than the Wallis No. 1 and more or less in agreement with advance seismic determinations. The first Frio sand, which was entirely gas-bearing in the Wallis No. 1, was logged at 9,173–9,195 feet and was found to be oil-saturated

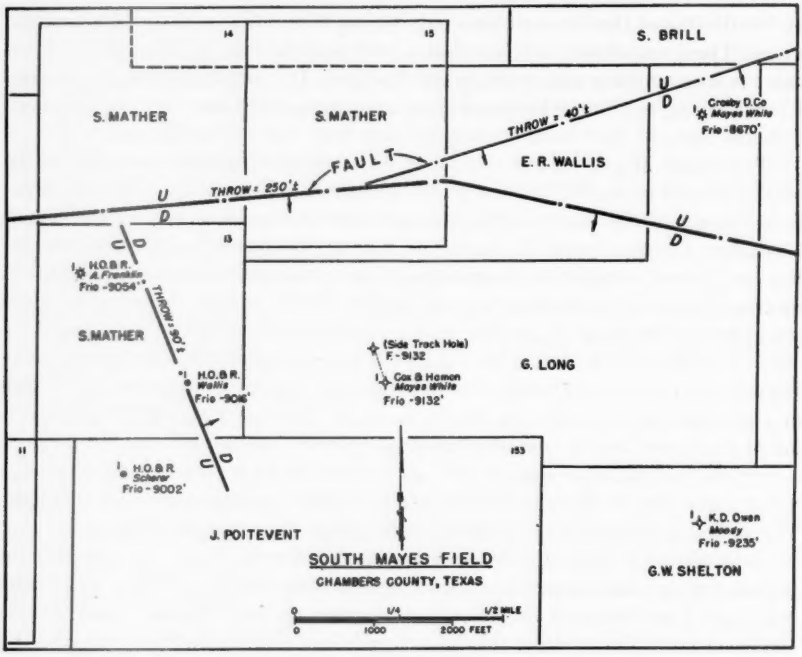

Fig. 1

throughout. This sand section was composed of an upper 5-foot member and a lower 13-foot member, separated by a definite shale break. Three attempts were made to drill-stem test the upper 5 feet, but all of them failed.

Core analyses of this sand section produced the following averaged data. For the upper 5 feet of sand: permeability 198 millidarcys; porosity 36.2 per cent; oil by pore space 7.7 per cent; water by pore space 50 per cent. For the lower 13 feet: permeability 500 millidarcys; porosity 32 per cent; oil by pore space 9.7 per cent; water by pore space 52 per cent.

As interpreted, the core analyses placed the sand in a doubtful category, with

a slight chance to make a well but with the probability that water percentages would be high. The electric log, however, largely nullified the favorable aspects of the core data. The electric record showed no resistivity on either third or fourth curves, except in the top 2 or 3 feet of the section where a weak resistivity was registered. There seemed to be clear evidence that almost the entire section was waterlogged and the possibility that the upper 3 feet would yield commercial oil was insufficient to justify a completion attempt. The test was drilled to 10,000 feet and found water in all of the lower sands.

The oil saturation in the first Frio sand led to the conclusion that the Mayes White No. 1 had penetrated the reservoir at the margin of a commercially productive area and that this area should have a combined gas-oil column of approximately 100 feet, as established between the Wallis No. 1 and the Mayes White No. 1. Since the beds should normally rise north within the trap and since the exact position of the main fault was still in question, the decision was reached to sidetrack the hole northward in an effort to reach the sand at a position that was appreciably above the water contact.

During September, 1946, the Mayes White No. 1 was whipstocked at 4,892 feet and was drilled out at an average angle of 10°. On the top of the Frio, the bottom of the side-track hole lay approximately 500 feet north and slightly west of the original hole. The side-track hole cut the first Frio sand at a corrected depth of 9,149–9,175 feet and logged 20 feet of gas sand, with no appreciable oil saturation. There was a slight vertical overlap of the sand in the two holes, the base of the gas sand in the side-track extending 2 feet into the oil column in the straight hole, indicating that about 20 feet of structural elevation had been gained by the sidetracking operation.

A correlation of the electric logs of the two holes shows several shifts in structural relationship through the side-track interval. For example, at 7,500 feet, an acceptable correlation places the side-track hole 30 feet high. The side-track hole consistently lost comparative structural elevation from this point down to a depth of 8,900 feet where it was 34 feet low. At 9,200 feet, it had regained most of this loss and was 20 feet high. These shifts between the two holes are to be accounted for by a thickening of section due to the angle of the side-track and by faulting. Two faults that cut both holes are readily recognized below 7,500 feet and several small faults may be postulated.

The side-track hole cut a 30-foot fault at 7,570 feet. The straight hole cut the same fault, with equal throw, at 7,700 feet. This fault is downthrown toward the coast, the same direction of throw as the main east-west fault that crosses north of the well. The straight hole cut a 40-foot fault at 8,690 feet and the side-track cut what appears to be the same fault with a throw of 45–55 feet, at 8,920 feet. This fault is upthrown toward the coast, an apparent minor adjustment to the main fault.

Core analyses of the gas sand in the side-track hole showed a high water content and the electric log again failed to register a resistivity that would indi-

cate commercial production. In effect, the two holes showed a continuous gas-oil column of more than 40 feet, all of which was waterlogged.

It is exceptional to encounter a 40-foot gas-oil column that is water-invaded in a reservoir that has not been depleted by production. In order to explain this occurrence, two different theories are advanced. First, that the oil and gas that are now found in the sand are residual fractions, the recoverable content having been depleted by drainage across a fault, probably the main east-west fault at the north. This fault is downthrown toward the coast with a displacement that is estimated at 250 feet. The first Frio sand, with which we are dealing, would be in contact across the fault with the Wallis group of sands, if displacement approximated 200–300 feet. This explanation seems to fit the structural factors that are available at this time. One additional piece of supporting evidence is of interest. K. D. Owen's Moody No. 1, located 4,300 feet southeast of the Mayes White No. 1 and, as far as factual evidence is concerned, in the same fault block, found a fair section of residual oil saturation in the first Frio sand, while occupying a position that is 200 feet lower than the Mayes White No. 1.

The main weakness in this theory is that we are dealing with a depleted gas column and a depleted oil column in the same sand, with a proper relationship between them. If depletion of a sand that was being fed normally from a source had occurred through leakage across a fault, then such movement should have taken place at a stage before a gas cap had formed and the residual content of the sand should either have been limited to oil alone or there should have been no residuum in the sand whatever. In other words, it seems highly imaginative to contend that oil from a normally supplied trap, could have migrated upward to the crest of a reservoir and escaped across a fault, leaving behind a depleted gas column that is oil-free, underlain by a depleted oil column.

Another conflicting point in this theory is that normal accumulation has taken place in at least two of the blocks that comprise the South Mayes fault block group. West of the original Humble-Wallis oil well, two additional commercial wells have been completed, the Franklin No. 1, a gas-distillate well in the first Frio sand and the Scherer No. 1, an oil well in the second sand. These three wells are in a block that is separated from the Mayes White No. 1 by the 90-foot Wallis fault except possibly the first Frio gas sand in the Wallis No. 1; but the block is assumed to be controlled by the main east-west fault on the north. If depletion of the Mayes White block has resulted from leakage across the main fault on the north, it is difficult to explain why the reservoirs in which the three western wells are finished have not suffered similar losses.

The second theory that is here being advanced overcomes some of the objections that can be raised regarding the first theory but it still leaves much to be desired. The laws that govern the migration of oil are very little understood. The same statement may be made regarding the source of oil. It is not difficult to think of the migration of oil from a large open source area, to be trapped by structures that interrupt the regional inclination of the beds. Some traps, how-

ever, are in lenticular sands that shale-out in all directions so that no porous connection with distant areas of source exists. Other types of closed structures are formed where blocks of sediments are completely isolated by faults. Recognition of these closed traps often waits upon production performance, where abnormally high initial pressures or rapid pressure drops indicate a lack of hydrostatic balance. Some of these closed traps are barren of oil or gas whereas others are fully loaded. If it is assumed that other structural factors are favorable, the determination whether a closed fault block is barren or productive would largely depend on the time relationship between migration and fault movement.

None of the varied circumstances here set out exactly fits the Mayes White fault block but it is probable that the explanation of the exceptional conditions that are here being discussed lies somewhere in this time relationship. It has been pointed out that the immediate area is cut by numerous faults, with several faults of sizeable displacement having been mapped in a tentative pattern. Numerous other faults have been identified in one or more wells but these can not as yet be tied into the general fault scheme. No tests except the one Owen dry hole have been drilled on the southeast side of the prospective territory and it is possible that there is a strike fault in this general locality that is complementary to the main east-west fault and forms a graben of the area immediately surrounding the Mayes White test. According to the time relationship, such a fault may have arrested migration into the Mayes White block in its early stages and cut off water circulation that would have brought about a proper adjustment of the limited quantities of fluids and gases that now occupy the reservoir. It is believed that this theory, while incomplete and unsatisfactory, more nearly meets the conditions in the area than any other. Unless oil has been depleted by the means set out under the first theory, then it may be assumed that the under-saturation encountered in the Mayes White tests is to be explained by the interruption of initial migration into this localized fault block.

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DISCUSSION

DIAGENESIS AND WEATHERING[1]

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In the January number of the *Bulletin*,[3] W. C. Krumbein, in discussing post-depositional changes in sedimentary deposits, suggests that "If the definition of diagenesis is broadened sufficiently, it may include weathering changes." From this and subsequent remarks one may infer that Dr. Krumbein is in favor of redefining diagenesis in this way.

The term *diagenesis* now has a fairly definite meaning for geologists the world over, referring to those changes which take place in sedimentary deposits on the bottoms of seas and lakes during and soon after deposition and before deep burial. Such changes are mostly chemical and bio-chemical, with strictly physical changes subordinate.

Weathering, on the other hand, is generally understood to mean the changes in rocks and sedimentary deposits at and near the surface of the lands. Krumbein remarks that "The subject of weathering is a science in its own right." Why then suggest that it should be merged into diagenesis by an extension of the definition of the latter?

If we are not to make a distinction between weathering and diagenesis, what shall we do about hydrothermal metamorphism, involving chemical changes which are induced by solutions, acting commonly near the surface of the earth. These changes resemble those involved in weathering even more than do the alterations called diagenesis.

It must be admitted that there is no sharp line of division between any of these groups of processes. They intergrade with one another, as is common in geology; hence, boundaries between them must necessarily be arbitrary. Nevertheless, it is distinctly useful to make and to recognize such divisions, for, regardless of marginal intergradations, there is a central concept which is distinct and important.

W. C. KRUMBEIN (Northwestern University, Evanston, Illinois, February 17):

Doctor Blackwelder has properly called attention to an implied redefinition of the term diagenesis in my extension of the word beyond its usual meaning. The original treatment should perhaps have indicated explicitly that I sought to point out a complexity rather than to modify an accepted terminology. My intention was mainly to indicate that in the post-depositional history of sediments there could be an episode of surficial weathering with the development of a soil profile; and if the profile is subsequently buried, it would undergo changes which in a sense are diagenetic. As a result of such post-depositional history the final sedimentary product would present a complex of true diagenetic changes, weathering changes, and post-weathering alteration. In effect, the discussion sought to draw attention to Doctor Blackwelder's point that there is no sharp distinction between these groups of changes, and that for some purposes the segregation of different types of diagenetic change may be important in the interpretation of ancient sediments.

[1] Manuscript received, February 5, 1947.

[2] Professor of geology, emeritus.

[3] W. C. Krumbein, "Analysis of Sedimentation and Diagenesis," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 31, No. 1 (January, 1947), pp. 168–74.

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RESEARCH

FUNDAMENTAL RESEARCH IN SEDIMENTOLOGY[1]

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The reconnaissance survey of research needs in petroleum geology, which was conducted by the Research Committee of 1945–46, resulted in the selection of nine projects in April, 1946, to which three more have been added, making a total of twelve. Eleven of these have been assigned to project chairmen and preliminary formulations have been prepared.

Emphasis has been placed on sedimentology, and, of the twelve subjects selected for further investigation, eight are in that general field. It has become increasingly evident, as work has progressed, that there are no real boundaries between these eight projects, and, at the January 15 meeting of the Research Committee at Wichita, it was decided that they should be merged into one program of fundamental research in sedimentology to be organized as an integrated physical, chemical, and biological investigation of the environments and products of deposition and post-depositional change in argillaceous and carbonate sedimentary deposits and their more important constituents, such as organic material and formation water.

This report discusses the need for and possible organization of such a program and gives a résumé of the component elements. It contains the following sections.

Orientation and scope of activities, page 501
Selection and formulation of projects, page 502
Presentation of progress report to A.P.I., page 502
Need for a well balanced program of fundamental research in sedimentology, page 502
Analysis of sedimentology with reference to needs of petroleum geology, pages 503–504
Outline of a program of fundamental research in sedimentology, pages 505–507
Résumé of projects 1, 2, 3, 4, 5, 6, 7, 8, and 12, pages 507–512
Further work needed to outline program, page 512

ORIENTATION AND SCOPE OF ACTIVITIES

We have aimed our projects at that part of the fundamental field which we conceive to be close to applied research. We grant that long-range "academic-fundamental" research is essential to the development of our science, but we consider it to be outside of our province. We grant also that the boundary between fundamental and applied research is neither sharp nor fixed, but varies with time and place in response to many economic factors and the state of our knowledge. We have, therefore, tried to design our projects so as to fill the needs that lie just beyond applied research as we conceive it to be practiced at the present time.

We have also tried to maintain a consistent point of view and axis of orientation, namely, to construct research projects which are designed to give us tools with which to improve our performance in finding and producing oil and natural gas. This objective would appear to be served best by concentrating the majority of the early work on Recent and Pleistocene sediments where it may be possible to set up the sedimentary analogs of physical constants and laws of relationship, or at least to produce closer controls on the sedimentary variables. In formulating these projects, we have had equal regard for their full development and for the limit of diminishing returns.

[1] Manuscript received, February 5, 1947.

[2] Chairman, research committee.

SELECTION AND FORMULATION OF PROJECTS

It was apparent, at the time they were selected, that there was considerable interrelationship between the eight projects in sedimentology. However, they have been prepared as distinct segments, rather than as a program, because the A.A.P.G. has inadequate funds for the support of a major research program, and a survey of several hundred members indicated strong opposition to a proposal that the Association should take an active part

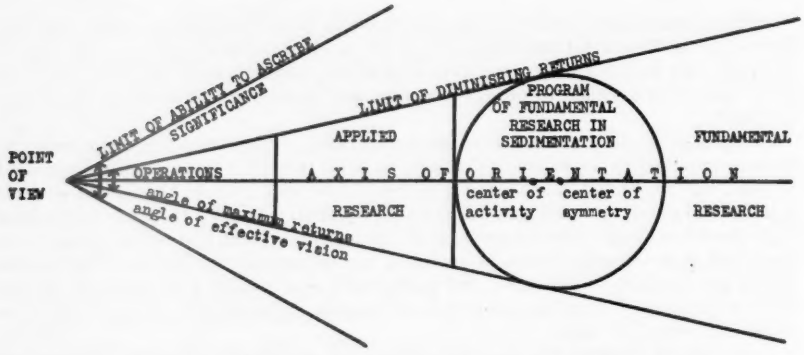


FIG. 1.—The volume of activity decreases geometrically away from the point of view. Hence the center of activity in a symmetrically developed program would be displaced away from the center of symmetry toward the point of view.

in raising such funds. The committee, therefore, has directed its attention to further survey and analysis of specific subjects, in the expectation that some of the resulting projects would merit the approval and recommendation of the Association, and acceptance by research agencies which are organized to finance worthwhile research of this general nature.

PRESENTATION OF PROGRESS REPORT TO A.P.I.

On November 12 the writer presented a progress report on several of the projects before the American Petroleum Institute, Advisory Committee on Fundamental Research on Occurrence and Recovery of Petroleum. This report was made with the approval of the Research Committee and the Executive Committee of the A.A.P.G.

The ensuing discussion by the membership of the A.P.I. committee was generally favorable and a motion was passed empowering the chairman, Mr. Gaylord, to set in motion the necessary machinery for further consideration of our projects when they are completed and have the approval of the Executive Committee, presumably shortly after the annual meeting on March 24-28, 1947.

The progress report contained one important departure from our previous planning, in that the writer stressed the interrelationship of our projects, and the need for an over-all program of fundamental research in sedimentology. The ensuing discussion of this topic indicated that it would be advisable for us to present our results both as specific projects and as a well rounded program.

GENERAL ANALYSIS OF PROGRAM OF FUNDAMENTAL RESEARCH IN SEDIMENTOLOGY

Ten years ago it was suggested that research on clay minerals would produce extensive values for petroleum geology and engineering. To-day the need for more knowledge of

clays is so acute that many companies are undertaking, at individual expense, work which is of general interest.

This is only one of many examples, but it serves as an illustration of the need for knowing more about sediments so that we can evaluate the significance of our ignorance and plan specific projects to plug the more conspicuous gaps. The probable significance of such values to exploration can be appreciated by considering the gross methods that are presently available for such problems as subsurface evaluation of unconformities and the location of the wedge edge of sand bodies.

The values to production engineering would probably be equally great. Engineers who apply measurements, based on the few known quantities, find the value of their results limited by the "L factor," which is the basket-term for the mass of unknown sedimentary variables. There probably will always be a residual "L" in our calculations, but at present it is far greater than it needs to be, considering the techniques that are presently available for the investigation of many of its components. In terms of dollars and cents, the unknowns of the "L" factor are probably costing far more, in reduced efficiency of operations, than the cost of the research needed to bring them in line with the other limiting factors of the problems.

There appear to be two principal obstacles to formulating a program of research designed to fill these needs. In the first place, sedimentology is a very extensive subject dealing with many categories of related and even interdependent variables. In the second place, the investigation of any restricted class of variables might produce values and relationships that hold good in the laboratory but which, when applied to practical field problems, would be liable to invalidation by interdependence on other parts of the "L" factor which were not included in the investigation.

An integrated field and laboratory investigation of the principal classes of sedimentary variables that bear directly on the problem would be extensive—but it does not appear that it would be disproportionate to our needs or to the expectable results. The principal objection to such a program is that it would contain the elements of many hundreds of man years of work. The same objection could be advanced against almost any project or project segment. The key to the program would be to hold the degree of detail to *significant approximations* and to plan successive stages from the more general to the more detailed. The first step in such a procedure is the most general and brings out the following apparent relationships.

PETROLEUM GEOLOGY

PRINCIPAL LINES OF FLOW OF KNOWLEDGE IN DEVELOPMENT OF SUBJECT SUBDIVISIONS.

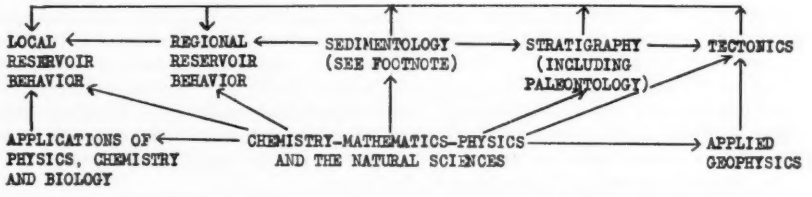


FIG. 2.—Sedimentology is used here as including sedimentary and biological aspects of the environments of deposition, the processes of post-depositional change, the biological and lithological characteristics of the sedimentary rocks, including sedimentary mineralogy and formation fluids: in other words, all the materials (insofar as they may be considered as component particles of the sedimentary rocks), the processes by which they are produced or altered, and their interrelationships as they occur *in their natural state*.

From this point of view, the central core of fundamental research in petroleum geology is the investigation of those physical, chemical, and biological characteristics, relationships in sediments and reservoir fluids, which are most significant to the principal fields of activity in exploration and production.

A further analysis of sedimentation might help select the general fields in which the *most significant investigations* might be located. In the following diagram geological time factors are plotted against classes of materials or fields of knowledge.

	Fossils and fossil producing organisms	Biochemistry and bacteriology	Clay minerals	Other components of clastic* sediments	Stratal properties of clastic* sediments	Non-stratal mass properties of clastic* sediments	Carbonate minerals	Other components of carbonate sediments	Stratal properties of carbonate sediments	Non-stratal mass properties of carbonate sediments	Interrelated physical and chemical properties of sediments and formation water	Organic constituents of the sediments
Dynamic factors of present environments												
Distribution of variables in most-Recent bottom muds (approximately 3 feet selected as practical thickness for reconnaissance)												
Incipient stages of post-depositional change in young Quaternary strata												
Distribution of sedimentary variables in older strata												
More advanced stages of post-depositional change												

* Including clay, silt, sand, gravel; excluding clastic dolomite and limestone.

Stated in another way, the above diagram plots conditions as they exist in nature against the compartmentalized fields by which we must conduct the investigations.

One other valid generalization that appears to bear on the problem of outlining a general program of fundamental research in sedimentation is based on the distinction between the problems of carbonates and clastics, both as sediments and as reservoir rocks. It seems clear that the program should be divided into two main parts, clastic and carbonate, and that each of these should be subdivided on the basis of Quaternary (Recent sedimentation and incipient post-depositional change) and pre-Quaternary sediments. It follows that there should be at least four principal regions from which to collect the materials to be used in the various topical investigations. These four regions might be as follows.

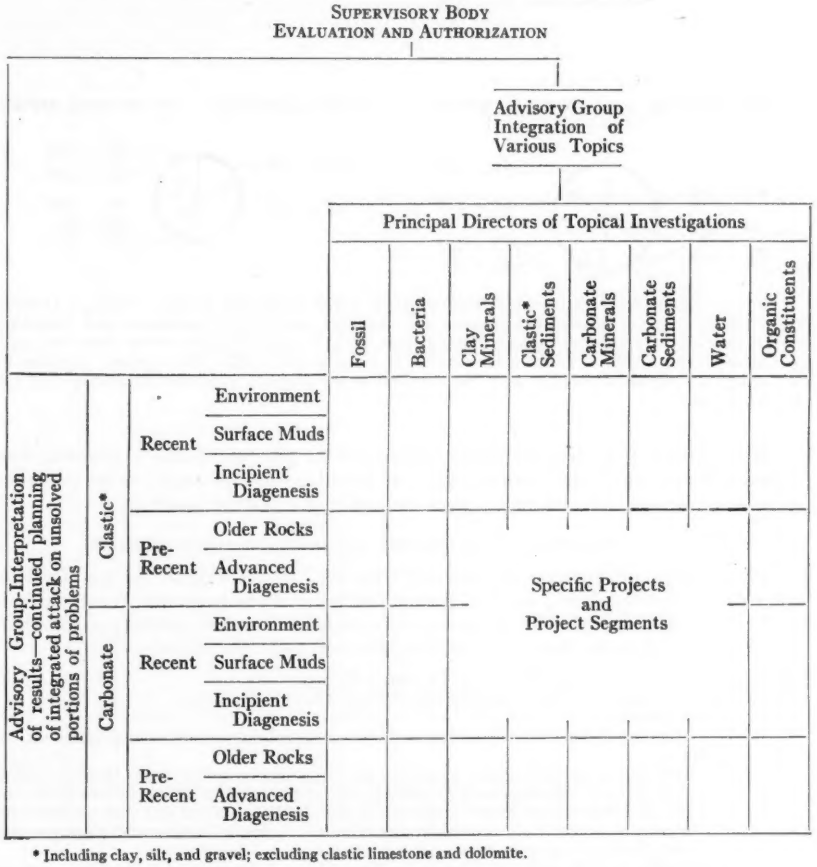
1. Recent clastic sediments (northwest Gulf of Mexico)
2. Older clastic sedimentary rocks (some part of the Pennsylvanian of Illinois)
3. Recent carbonate sediments (northeast Gulf of Mexico)
4. Older carbonate sedimentary rocks (Ordovician of Kansas)

The regions listed are for example only. The ultimate selection would be a compromise and would depend on the needs of all the different "topical" investigations, water, clay, bacteria, *et cetera*. For any particular investigation, materials might also be drawn from other regions than the one selected as the general type. For instance, the purposes of the

bacterial investigations might be served better by material from the Pacific Coast clastics or the Bahama carbonates. Therefore, the selection of *one* province in each of the four geological categories would not be intended to be restrictive, but only to serve as the focal region in which the different lines of investigation could be integrated.

Another form of integration would appear to be necessary. The investigation of any given topic, such, for instance, as formation water, might be conducted by several different groups of workers, and the director of one of these groups might be charged with the responsibility of coordinating all the results obtained within that particular topic, whether Recent or Ancient, clastic or carbonate.

This two-fold coordination would lend itself to the following type of organization.



* Including clay, silt, and gravel; excluding clastic limestone and dolomite.

GENERAL OUTLINE OF PROGRAM OF FUNDAMENTAL RESEARCH IN SEDIMENTOLOGY, WITH REFERENCE TO NEEDS OF PETROLEUM GEOLOGY AND ENGINEERING

The principal controlling factor in the development of a program of research in sedimentology is that the materials used in all but some of the experimental phases must come from natural environments.

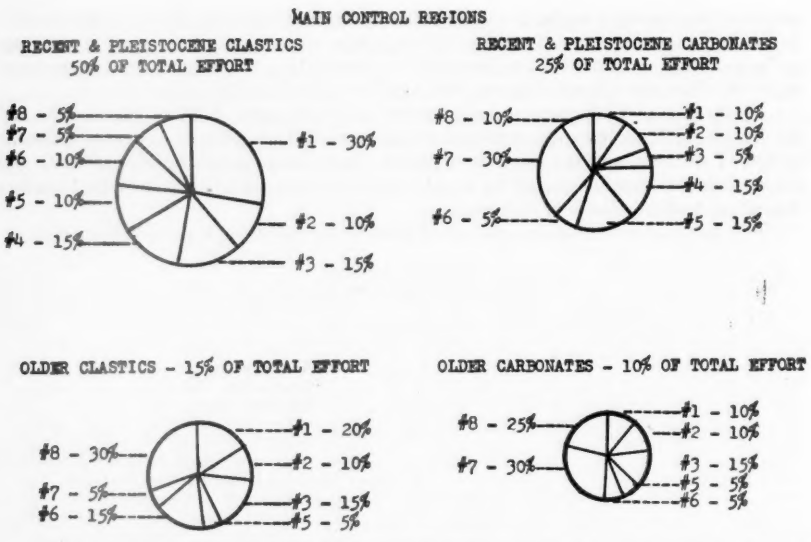


FIG. 3.—Example of way in which total program might be divided. 1, Clay, 21.5%; 2, Organic constituents, 10%; 3, Interrelated physical and chemical properties of sediments and formation water, 12.5%; 4, Bacteria, 11.25%; 5 (part) Fossils, 10%; 6 (part) Clastics (other than clay), 9%; 7, Carbonates, 13.75%; 8, Differential solution and deposition, 12%. (The segment numbers in this diagram correspond roughly with the numbers of the projects which are summarized in the following text.)

It is desirable that all of the principal topics of the program should be conducted on materials from each of the four test regions so as to improve our ability to see the interrelationship between the different regions and different classes of materials.

OUTLINE OF PROGRAM OF FUNDAMENTAL RESEARCH IN SEDIMENTOLOGY

These eight topical groups, in four control regions, show at a glance the need for first-order reconnaissance during the initial stages of most of the program. The exceptions would be the marine regions where the cost of occupying a station justifies greater attention to detail in the investigation of material from each of these stations.

I. Recent Clastic Region and II. Recent Carbonate Region
   A. Continental portion (bays, swamps, lagoons, offshore bars, *et cetera*)
      1. Reconnaissance
         Mapping of depositional environments by physiographic and other available data
      2. Detail
         Selection of transects (belts 10 miles wide perpendicular to the coast) through typical environments. Measurement of salinity, pH, and redox at selected stations under the normal range of conditions. Collection of samples from surface and from shallow core holes 5 to 20 feet deep. Preliminary examination in the field of less stable components such as clays, water, bacteria; more detailed work in laboratory
      3. Incipient post-depositional change. Drilling of core holes ranging to 400 feet deep at selected stations. Examination by all branches of investigations to determine degree and nature of change with depth
      4. Continuation of investigations downward through the Pleistocene, which, together with the Recent, reaches a thickness of nearly 4,000 feet at the seaward edge of Mississippi delta

B. Marine portion (continental shelves to Sigsbee Deep)
The interests of economy appear to be served best in marine investigations by combining the clastic and carbonate control profiles in a single extended cruise, outfitting a suitable ship and conducting those investigations on board which need to be done at location, such as parts of the work on water, clay, bacteria, organic matter, and the interrelated physical and chemical properties of the sediments and their contained water.

It is suggested that the carbonate control profile should be located off western Florida, rather than Yucatan, for reasons of accessibility to subsequent investigations which might appear to be desirable. The continental shelf west of Tampa is preferred to the area of the Florida Keys because of possible mixing with Caribbean water in the more southern area. The Tampa profile is well within the Gulf and should provide relatively typical Gulf of Mexico carbonate deposits. Since it would be useful to compare the results of the investigations in the clastic and carbonate regions, it would be desirable, from this point of view, for both to be in the same general province.

III. Region of Clastic Rocks and IV. Carbonate Rocks

1. Survey of all significant data in project region and within selected formation or group of formations; cooperation of companies and other sources of data essential
2. Collection of readily available cuttings, cores, and water samples for spot check on key points of survey
3. Selection of three control profiles constructed so as to cross regional and local conditions of particular interest
4. Collection along profiles of special samples and a few complete sets of cores through the formation or group selected for investigation.
5. Examination of all cuttings and every inch of cores by visual techniques and a few somewhat more detailed investigations where desirable.
6. Interpretation of reconnaissance results and selection of key samples for detailed investigation of all major topics; this selection to be made in such a way that the results of these investigations will bear the greatest relationship to regional and local indications of depositional environments and factors of post-depositional change.

RÉSUMÉ OF A.A.P.G. RESEARCH COMMITTEE PROJECTS IN SEDIMENTATION AND RESERVOIR FLUIDS

Clay Minerals
A.A.P.G. PROJECT 1

The initial objective of the clay mineral project is to increase our information concerning the properties and the patterns of behavior and distribution of clay minerals in Recent and older sediments, with special reference to the needs of petroleum geology and engineering. These needs would appear to be served by the development of basic clay-mineral data that would help in the search for specific relationships of clay minerals to all types of well logging, core analysis, reservoir behavior, porosity and fluid saturation, variations in permeability, indices of depositional environment and source beds of petroleum.

There is, presently available, a large body of existing information and developed techniques, including X-ray, thermal, and chemical methods of analysis. The arrangement and distribution of the clay particles in the rock can be investigated by a variety of physical and microscopical techniques.

This is visualized as a long-term project concerned with the development of fundamental knowledge, but the field is so active and so relatively new, in its application to the exploration and development of petroleum, that many practical by-products might be expected.

The value of these data and known relationships to the improvement of our present techniques would probably be very extensive. In addition, a large part of these investigations would have direct bearing on the increased use of clays as acid catalysts.

Organic Sediments
A.A.P.G. PROJECT 2 (PART)

The objective of the organic sediments project is to investigate the facts relating to the occurrence and alteration of organic material in Recent and pre-Recent sediments, and the relationship of these facts to the other sedimentary variables.

It should be stressed that there is no intent to duplicate the work of A.P.I. project 5 or to overlap the current work of Project 43. The organic sediments project is located in the same general segment of the sphere of geologic research as A.P.I. 5 and 43, but its purpose is to improve our knowledge of fundamentals of sedimentation rather than to make a more direct attack on the problems of beds or of other factors of origin.

This project is closely related to the work that would be done on formation waters. Part of the results derived from A.P.I. 43A (bacteria) would be directly applicable. The organic sediments and clay minerals investigations are also closely interrelated and one almost necessitates the other. Furthermore, the amount of organic material has a pronounced affect on the pH and the redox potential as well as the oxygen and carbon dioxide tension and concentration in Recent environments and the underlying muds.

There are numerous techniques and a large body of information that could be directly applied to the problem. The results of the investigation of bacterial activity in peat and coal seems to be particularly applicable.

The design of this project should be long range and fundamental. Direct applications are not expected. However, it is probable that the investigation can be so concentrated in the field of our most significant ignorance that it will produce leads that can be followed by subsidiary investigations to practical conclusions.

Formation Waters
A.A.P.G. project 3

The initial work on the formation waters project would consist in the collection of data in two or three selected areas and the correlation of these data to other geological occurrences that are significant to our purposes.

The analytical phase of this work should include uncommon characteristics as well as those commonly identified. Sodium and potassium should be measured separately also ammonium, barium and strontium if present. Organic acids should be measured and calculated as naphthenic acid, by the electric-titrimeter. The usual Palmer interpretation should be made in addition to calculation of hypothetical combinations.

The formation waters, when completed, would furnish a set of rules and limitations concerning the direct and indirect significance of formation waters in reference to some of the other factors of their geological environment.

This project is fundamental in general outline but may have some practical application. From the point of view of fundamental investigation in sedimentation, the formation waters are a part of the geological environment and must be evaluated before we can hope to reconstruct the broader outlines of the picture, particularly in the field of post-depositional changes in clay minerals and carbonates, and cementation of clastics.

The composition of the water is also of prime importance from the viewpoint of deposition and incipient post-depositional change in Recent and near-Recent sediments. It exerts primary control not only on the distribution of flora and fauna, but probably the clay minerals as well. The exchange of cations between water and clay is one of the more significant factors in post-depositional change in fine-grained clastics, and waters are probably the principal agent in the transformation of limestone to dolomite.

It would be virtually impossible to construct a valid program of fundamental research in Recent sediments, either clastic or carbonate, without extensive consideration of the water of the environment and in the sediments.

Bacteria Project
A.A.P.G. project 4 (part)

The purpose of the bacteria project in Recent and near-Recent sediments is to discover the principal functions of bacteria in the deposition of carbonate, organic, and fine-grained sediments, and to investigate the more important aspects of bacterial activity and biochemistry in post-depositional change.

Clay minerals, organic sediments, formation water, and bacteria are all essential materials in an investigation of modern environments, the distribution of variables in Recent fine-grained clastic sediments, and the incipient processes of post-depositional change.

Much has been added in recent years to the techniques of bacteriology and biochemistry as they apply to sedimentology. Bacteriological work on soils or sediments is being done at several academic institutions and is being planned at one or more others. It is probable that the project could be placed advantageously.

The project is fundamental and no practical by-products are anticipated, although, of course, they may occur, and all investigations should be scrutinized for important leads.

Recent Sediments
A.A.P.G. project 5

The recent sediment project is described as the investigation of Recent sediments of the northern part of the Gulf of Mexico and adjacent areas of continental deposition.

The initial objective is to increase our knowledge of three related groups of things which are: first, the processes and products of depositional environments; second, the areal distribution of the more significant variables in Recent clastic and carbonate sediments; and, third, the processes and products of post-depositional changes in the Upper Quaternary.

These investigations are planned to include fossils and fossil-producing organisms, limestone reefs and bedded deposits, initial processes of solution and crystallization, incipient dolomitization, development and filling of porosity; the grain-size distribution and grain characteristics of clastic sediments, clastic minerals including heavy minerals, volcanic glass, glauconite, the micas and especially the clay minerals; bacteriology and biochemistry; the interrelated physical and chemical properties of the sediments and formation waters.

The ultimate objective is to improve our ability to distinguish in sedimentary rocks the products of environmental and post-depositional processes and thereby increase our leverage on such problems as origin and migration and the identification of those factors which control the selective accumulation of oil and gas in favored trends, structures, and reservoirs.

These classes of data would probably provide control for many of the presently unknown components of the "L" factor (which is the designation for the group of lithologic unknowns encountered in core analysis), and thereby aid in evaluation of reservoir performance.

Ancient Sediments
A.A.P.G. project 6

The initial purpose of the ancient sediments project is to measure and map the distribution of sedimentary variables in selected typical geological environments.

These variables reflect both environment of deposition and post-depositional changes and the results of these two sets of processes must be disentangled before we can understand the implication of any given set of conditions in the sediments and predict their horizontal or vertical extension. However, the first step is to map the horizontal and vertical distribution of the variables as we find them.

It seems probable that correlation between Recent and ancient patterns of distribution of sedimentary variables can be made better at a later stage in the investigation, after an unprejudiced evaluation of each has been made in terms of the known factors of the modern or geological environment in which each is now located.

Among particular aspects which require further investigation is the influence of processes of post-depositional change operating through geologic time on the modification of the characteristics of clay minerals by base exchange and other alterations particularly as they effect variations in porosity and permeability.

Carbonate Porosity
A.A.P.G. project 7

The specific objective of the carbonate porosity project is to improve our understanding of the nature and the manner of origin of porosity and permeability in carbonate rocks. More broadly this would involve consideration of the processes and products of deposition and post-depositional change.

Particular attention would be directed toward the origin and development of "primary" and "secondary" dolomitizations, and toward other types of "primary" and "secondary" porosity. The proposed program for attacking these problems includes X-ray, thermal, chemical, and petrographic techniques, core analysis, and plastic models.

These would be supplemented by investigation of solubility effects of weak acids, reductions of porosity by ground water, movement of fluids through porous carbonate media. Local and regional geological environments of carbonate porosity would be classified.

This project is basic in over-all design, although, of course, usable by-products might result at any time. An increased understanding of carbonate porosity would furnish the basis for a genetic classification which would be useful in correlating new areas of carbonate production with old areas that had a long production history. This would aid in the early evaluation of reserves and the most economical development of the new field.

Correlation of porosity with other geological features would aid in the prediction of new areas of porosity and the extension of old ones.

Cementation
A.A.P.G. project 8

The field of interest of this project is the entire field of post-depositional change in sedimentary rock and as such, it broadly overlaps all the other projects. Whereas some of the other projects may be attacked directly, at least in part, this one depends almost entirely on inference because the time factor prevents us from measuring the processes in operation.

Differential solution and the filling, or development, of porosity in clastics and carbonates are only part of these processes. Some of the others are migration of formation waters, alteration of clay minerals and carbonates, and resulting changes in porosity and permeability.

The subject of post-depositional change of sediments is hardly less difficult to get hold of that is the closely allied problem of origin, evolution, and migration of fluid, hydrocarbons. However, we probably know enough about Recent and ancient sediments to make some valid inferences as to the processes involved in the transformation from one to the other. Investigations based on some of these inferences have been included as segments of some of the other projects.

It may be that in constructing a program of fundamental research in sedimentation, the subject of post-depositional change should be regarded as a field of interest rather than as a project or group of projects. However, it is surely one of the focal points for the integration of the results of topical projects that are based on classes of materials, such as formation waters, clays, bacteria, carbonates, *et cetera*. It seems probable, therefore, that specific projects should be designed to implement that integration, by tying together the various lines of evidence, and investigating further their relationship to one another within the field of post-depositional change. Such a project might be designed to investigate some of the inferred processes of cementation of sandstones, by field observation and laboratory experimentation.

The general subject of post-depositional change contains so many problems that are of immediate economic importance that it would be necessary to design specific projects with care in order to keep them in the field of fundamental research. Numerous practical by-products would almost surely develop from such projects in a relatively short time.

Well Logging
A.A.P.G. PROJECT 12

There are two principal objectives for this project, the first of which is to make the various types of bore hole logging serve the more general purposes of the investigation of sediments and the second of which is to interpret as many of the results of the other investigations as possible in terms of bore hold logging so as to make these results the more readily available.

Many of the techniques that could be used in the interpretation are well advanced, and electrical or other logs may be available for many or most of the wells in a project area. These logs will surely be used. "In order to use logs to the fullest extent and to increase our ability to interpret them, special effort must be made in the laboratory and the field to investigate, record and digest, specific data and phases of the investigation peculiar to and for the purpose of interpretation of the logs."[3]

It seems probable that the development of a project with the objective here outlined would avoid the field of applied research but would produce results that would be readily applicable to that field.

Medium-Grained Clastics, Sands and Silts
A.A.P.G. PROJECT 7 (PART) AND 5 (PART)

No separate project was recommended for this subject because its treatment is covered in project 6 Ancient Sediments and to a lesser extent in project 5 Recent Sediments.

Medium-grained clastic sediments are one of the groups of sedimentary variables which, on the whole, remain relatively less altered by post-depositional change. They are, therefore, available for tracing the patterns of environment directly from the Recent into the older sediments.

The objective of this work is two-fold: first, to identify the sedimentary patterns which exist in Recent sediments and their relationship to modern environment; Second, to identify sedimentary patterns in older sediments and correlate these with the Recent.

In this work the grain-size distribution of the sediments is the most obvious and possibly the most effective tool. The shape and surface characteristics of the grain, such as frosting and pitting, should be investigated, particularly in relationship to clay coating. Microstructures of the sediments should also be investigated in thin sections and under the lower-power binocular (10x).

Most sands and silts are argillaceous and most marine clastics are calcareous, either because of or in addition to their fossil content. The investigation of the clastics, therefore, needs to be closely integrated with several other investigations in the Recent and the older sediments. Although the quartz may remain relatively unaltered, the calcareous and argillaceous fractions are subject to post-depositional change and must be considered in that connection as well.

A knowledge of the depositional patterns and the principal processes of post-depositional change of the minor constituents in medium-grained clastics would be of direct value in predicting areas and type of porosity and permeability in the subsurface. The results of this project would probably have so many practical applications that care would have to be exercised to keep it in the fundamental field.

Environmental Distribution of Fossils
A.A.P.G. PROJECT 5 (PART)

This subject also was not included by title in our original list of projects because it is a major part of the plan of project 5 Recent Sediments.

Investigation of the environmental distribution of fossil-producing organisms has two purposes: first, to furnish additional data on this class of evidence which has been found to

[3] According to G. E. Archie.

be the most valid index of depositional environment; and second, to give additional help in the problem of disentangling the environmental from the evolutionary variables, and thereby contributing directly to the value of paleontological criteria in stratal correlations.

Preliminary work on this item indicates a close interrelationship between this project and several other fields of sedimentation. The distribution of the organisms appears to depend to a large extent on the character of the bottom sediments, and the fossil remains form a significant part of the sediments in which they are buried. This branch of paleontology, therefore, appears to form a valid and an essential segment of a program of fundamental research in sedimentation.

Carbonates as minor constituents of clastics A.A.P.G. project 5 (part)

No project has been designed to investigate the carbonates in clastic regions and yet they occur in abundance as minute disseminated particles and constituents of particles, as calcareous fossils, and as calcareous oozes in deeper-water deposits.

Parts of the carbonate investigation might be carried on under other projects (clay minerals, bacteria, carbonate rocks, cementation, *et cetera*), but there would probably be a residue of material that would be given more satisfactory treatment under its own classification.

Further work needed to outline program

The next step in the development of our program is to define specific problems that could be undertaken in the several topical divisions of the general subject of sedimentology. These can then be graded in relation to our objectives, the estimated significance and scope of results, time and cost of proposed investigations, and other evaluating factors. The various segments could then be placed in the framework of a general program in which it should be possible to see their relationship to our needs and to limiting conditions.

It is hoped that the preliminary draft of a workable program may be completed by the annual meeting this year.

Acknowledgments

The preliminary formulations which have been prepared by the chairman of the several projects have been drawn on heavily in the preparation of the résumé of projects. The need for a program of fundamental research in sedimentology has been discussed with members of the Research Committee and, in particular, with Marcus A. Hanna, vice-chairman of the committee. Many other members of the Association have contributed generously of their time and ideas. While it has been necessary for the writer to write this note "as he sees it," he has attempted to subordinate personal experience to the point of view of the Association as a whole. The assistance of those who have contributed to this attempt is gratefully acknowledged.

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STRATIGRAPHIC COMMISSION

NOTE 1—ORGANIZATION AND OBJECTIVES OF THE STRATIGRAPHIC COMMISSION[1]

AMERICAN COMMISSION ON STRATIGRAPHIC NOMENCLATURE

Original joint committee on stratigraphic nomenclature.—Geologists of North America are generally well acquainted with the statement of stratigraphic principles and rules for classification and nomenclature of rock units formulated in 1932 by a joint committee representing the American Association of Petroleum Geologists, Association of American State Geologists, Geological Society of America, and United States Geological Survey. This so-called Stratigraphic Code, commonly cited as the ASHLEY *et al.* (1933, 1939) report, has been published three times and has been used widely as a guide by individual workers and geologic editors. The value of the Code as a comprehensive, concisely stated presentation of generally accepted views on stratigraphic principles and procedures has been recognized despite its incompleteness and imperfection of treatment in various places.

The joint committee was not continued after it had formulated the Rules. At a final meeting of the committee on December 29, 1932, a motion was adopted recommending that questions of interpreting the Rules should be referred to the Committee on Stratigraphy of the National Research Council, but no special provision was made for encouraging such reference of questions or for dealing with them if they should be submitted. At least one important problem (Howe, 1933; Dunbar, 1934) involving principles of stratigraphic nomenclature as applied to Gulf Coast Tertiary rocks was brought to the attention of the Committee on Stratigraphy and by expression of committee judgment a satisfactory solution was found. Perhaps other cases were dealt with similarly but no published record of them seems to have been made. The Research Council committee was not asked to consider questions of amending phraseology of the Rules or of making any additions or subtractions; likewise the committee has given no attention to the possible need for modifications of the Rules. Inasmuch as the original joint committee was dissolved in 1932, no mechanism representing the several agencies that worked together to draft the Rules has been available for interpreting or amending them.

Organizations concerned with matters of stratigraphic classification and nomenclature have maintained or developed their own methods for obtaining reasonable uniformity in practice, most of them treating the 1933 statement of principles and rules as authoritative.

The American Association of Petroleum Geologists established a Committee on Geologic names and Correlations for the special purpose of helping members understand and follow the Rules in preparing publications for the *Bulletin*. Besides work on specific projects, this committee has regularly furnished advice to editors of the *Bulletin* in connection with usage of stratigraphic names.

The Association of American State Geologists has set up committees for study of discordant stratigraphic classification and nomenclature along various state boundaries and means for removing as much of this discordance as possible. The individual State geological surveys have their own internal control for deciding questions of stratigraphic nomenclature.

The Geological Society of America has no committee on stratigraphic names but relies

[1] The Commission intends to issue two sets of serially numbered communications: (a) informal statements, discussions, and outline of problems, which will be designated as *Notes*, and (b) formal pronouncements consisting of declarations, opinions, and recommendations, which will be designated as *Reports*.

on the advice of censors and an editorial board in reviewing papers submitted for publication by the Society.

The Geological Survey of Canada, which was not represented in the joint committee that prepared the Code, has a Committee on Geological Nomenclature, which has formulated rules governing stratigraphic names and terms employed in reports and map legends of that Survey.

The United States Geological Survey has long had its Committee on Geologic Names, which by recommendations to the Chief Geologist and Director essentially controls practice of the Federal Survey in all aspects of stratigraphic nomenclature. Many geologists who are not connected with the Federal Survey have referred questions of stratigraphic classification and nomenclature to the chairman of the Survey's Committee on Geologic Names and have received informal aid.

The several geological surveys and societies that have established internal bodies and procedures concerned with geologic names need these and doubtless will call on them throughout indefinite future time to serve the organizations. Such committees can help one another and can derive benefits from joint attack on common problems.

Renewal of joint organization in 1941.—Steps looking to re-establishment of a joint committee, like that which had written the Stratigraphic Code, were taken in May, 1941, when the president of the Association of American State Geologists invited the other organizations represented in the committee of 1930–1932 to nominate geologists officially empowered to serve as delegates to meetings planned to be held at Boston on December 29–30, 1941. Invitation was also extended to the Geological Survey of Canada. According to proposal, the purpose of the meetings was to determine the desirability of establishing a new joint agency designated tentatively as the Commission on Classification and Nomenclature of Rock Units. The American Association of Petroleum Geologists designated M. G. CHENEY, B. F. HAKE, and E. H. SELLARDS as its representatives; the Association of American State Geologists named G. H. ASHLEY, P. H. PRICE, and A. C. TROWBRIDGE; the Geological Society of America appointed C. O. DUNBAR, MARSHALL KAY, and W. H. TWENHOFEL; the Geological Survey of Canada named W. A. BELL, G. S. HUME, and G. A. H. NORMAN; and the United States Geological Survey named J. B. REESIDE, JR., W. W. RUBEY, and L. W. STEPHENSON. R. C. MOORE, who had proposed the conference, attended as a State geologist and served as chairman of the meeting. The appointed representatives were present at the Boston meeting, except BELL, CHENEY, REESIDE, and SELLARDS.

The delegates agreed that establishment of the suggested Commission on Classification and Nomenclature of Rock Units would doubtless contribute significantly to advancement of geology in North America by providing means for interpreting the Stratigraphic Code. The Commission could also best serve as agency for revising the Code from time to time in such particulars as should be judged desirable. The delegates concluded unanimously that the Commission should be organized without delay, even though war conditions made it unlikely that the Commission could start to function in the near future. Recommendation was made to the heads of organizations represented at the conference that establishment of the Commission be effected as soon as conditions permitted. The conference then adjourned.

During subsequent years until near the close of 1946, no meetings of the Commission were held nor was effort made by correspondence to undertake any joint work relating to stratigraphic classification and nomenclature. Most of the organizations which had been represented at the 1941 Boston meeting allowed Commission matters to drop, but the American Association of Petroleum Geologists regularly named representatives to serve three-year terms, one such representative being retired and a new appointment being made each year (B. F. HAKE, 1942–'43; M. G. CHENEY, 1942–'44, 1944–'47; J. G. BARTRAM, 1942–'45, 1945–'48; C. W. TOMLINSON, 1943–'46; W. V. JONES, 1946–'49). The Commis-

sion did not function, however, during the years 1942–1946.

Chicago meeting in 1946.—After VE and VJ days, in 1945, the time seemed propitious for resumption of efforts along the lines planned in 1941, but no specific proposals in this direction were made until July 2, 1946, when R. C. MOORE, as chairman of the Boston meeting, wrote to the five agencies that had joined in planning the Commission suggesting call of a meeting in Chicago at the time of the Geological Society of America meetings there. Representatives of the American Association of Petroleum Geologists were already named, but it would be necessary for other organizations to designate delegates. The meeting was set for Friday, December 27, 1946, at the Hotel Stevens. The Geological Survey of Canada was able to name only two delegates; the others each appointed three delegates. Thus, fourteen duly appointed representatives assembled at Chicago at the scheduled meeting, as follows.

MEMBERS OF COMMISSION ATTENDING CHICAGO MEETING
DECEMBER 27, 1946

GEORGE H. ASHLEY	Assoc. Amer. State Geol.
JOHN G. BARTRAM	Amer. Assoc. Petroleum Geol.
L. D. BURLING	Geol. Survey Canada
MONROE G. CHENEY	Amer. Assoc. Petroleum Geol.
CARL O. DUNBAR	Geol. Soc. America
J. M. HARRISON	Geol. Survey Canada
WAYNE V. JONES	Amer. Assoc. Petroleum Geol.
MARSHALL KAY	Geol. Soc. America
*HUGH D. MISER	U. S. Geol. Survey
RAYMOND C. MOORE	Assoc. Amer. State Geol.
PAUL H. PRICE	Assoc. Amer. State Geol.
JOHN B. REESIDE, JR.	U. S. Geol. Survey
W. W. RUBEY	U. S. Geol. Survey
W. H. TWENHOFEL	Geol. Soc. America

* Represented by JAMES STEELE WILLIAMS as alternate.

Adoption of articles of organization and procedure.—Attention was first given to adoption of articles of organization and procedure, a draft of which had been prepared. Satisfactory wording of these articles was arranged and unanimously adopted. They are published here for the information of all concerned, attention being directed especially to the statements on purposes of the Commission and those relating to procedures. It is appropriate also to emphasize the points that the Commission possesses no legislative powers and only in a qualified sense assumes judicial functions. Neither the agencies making appointment of Commissioners nor any individuals are under compulsion to follow opinions or recommendations of the Commission. It is an advisory body, the worth of whose expressions on stratigraphic matters is to be judged on their intrinsic reasonableness and on the breadth of the Commission's collective experience. The fact that minority, as well as majority, views of the Commission are planned for publication may be helpful.

ARTICLES OF ORGANIZATION AND PROCEDURE OF AMERICAN COMMISSION ON STRATIGRAPHIC NOMENCLATURE

I. *Name*

The name of the Commission shall be the American Commission on Stratigraphic Nomenclature.

II. *Purposes*

The purposes of the Commission are to develop statement of stratigraphic principles, to recommend procedures applicable to classification and nomenclature of stratigraphic units, to review problems in classifying and naming stratigraphic units, and to formulate expressions of judgment thereon.

III. *Members*

The Commission shall be composed of fifteen (15) members chosen as follows: three representatives each as designated by the

American Association of Petroleum Geologists
Association of American State Geologists
Geological Society of America
Geological Survey of Canada
United States Geological Survey

except that in event any of the named organizations does not designate representatives, members of the Commission otherwise chosen are empowered to invite participation by additional organizations or to designate members-at-large so as to make total membership of fifteen.

The terms of designated Commissioners shall be three (3) years, except that initial appointments by organizations will provide for retirement of one representative each year. Commissioners may be reappointed. In case of a vacancy, the agency that designated a Commissioner shall make a new designation to complete the unexpired term. For the purpose of determining the terms of Commissioners, a year shall be construed as the period from the end of one annual meeting of the Commission to the next.

IV. *Officers*

The officers of the Commission shall be a chairman and a vice chairman, who shall be elected annually by the Commissioners from their number. The chairman, or, in his absence, the vice chairman, shall preside at meetings of the Commission and shall have responsibility of maintaining records, supervising presentation of matters to the Commission, organizing actions and opinions expressed by the Commission for publication, and generally guiding the work of the Commission n accordance with procedures adopted by the Commission.

V. *Actions*

1. The Commission shall specify and establish procedures, including provision for obtaining statement of problems or cases in desired form and completeness, determination of steps in handling these matters by the Commission, and formulation of the Commission's opinions, declarations, and recommendations. The Commission shall exercise the option of accepting or rejecting consideration of questions that may be brought before it. Opportunity shall be given for recording minority as well as majority judgments.

2. The Commission shall have an annual meeting for the election of officers and for transaction of other business that it may choose to consider, such meeting being scheduled to coincide with the time and place of the annual meetings of the Geological Society of America. Additional meetings may be called by the chairman of the Commission. A Commissioner may designate an alternate to act in his stead at meetings he is unable to attend. For transaction of business at meetings eight Commissioners or their alternates shall constitute a quorum.

3. Much of the Commission's work may be carried on by correspondence between times of meetings.

4. A majority vote of the entire Commission is necessary for adoption of opinions, declarations, and recommendations concerning classification and nomenclature of stratigraphic units.

VI. *Publication of Actions*

The Commission shall prepare and offer for publication such record of its actions, including minority opinions, as it may deem significant. These statements may be issued either in the form of abstracts or full presentation. In cases where full statements are not published, manuscript file copies of such statements shall be provided and preserved for consultation by interested workers in such manner as the Commission may arrange. Published opinions, declarations, recommendations, or other actions of the Commission shall be numbered and dated in such manner as to provide suitable basis for ready reference and indexing.

VII. *Responsibility for Actions*

An organization making designation of representatives to serve as Commissioners shall not be bound in any way to observe procedures or follow judgments expressed by the Commission. Actions by the Commission shall be advisory and involve no commitments by other agencies, either expressed or implied.

VIII. *Finances*

The Commission is authorized to solicit and disburse such funds as may be needed for proper transaction of its functions.

IX. *Amendments*

Amendments to these articles of organization and procedure may be made at any time by majority vote of the Commissioners.

After the articles of organization and procedure had been adopted, the Commission elected officers to serve until the close of the next annual meeting of the Commission, which will be in Ottawa, Canada, probably on December 30, 1947. The officers chosen were R. C. MOORE, chairman, and M. G. CHENEY, vice-chairman.

Program of work.—The latter part of the Chicago meeting was devoted to consideration of the manner in which the Commission might best undertake its work. Agreement was reached that it was undesirable, at least for the present, to begin any extensive revision of the Rules of Classification and Nomenclature of Rock Units as published in 1933. Desirable additions, deletions, and modifications of statements were noted in connection with several articles of the Rules, but it was judged best to be deliberate in making changes.

It was decided to give attention first to individual cases or problems involving stratigraphic principles. Subjects for review by the Commission, which will serve as basis for Opinions, Declarations, or Recommendations to be published by the Commission, are expected to be brought forward by any person or persons interested, and questions may be submitted by an individual Commissioner or group of Commissioners as well as by others. Obviously, it is needful that presentation of a problem should be carefully and clearly prepared, with adequate, accurate documentation, and it is desirable that concisely stated arguments should be offered, pro or con, or both pro and con; finally, it is judged proper and desirable that one who refers a case to the Commission for study should submit statement of specific recommendations, which, if the Commission sees fit, may be adopted in formulating action. Sample statement of a problem incorporating these features was laid before the Commission by R. C. MOORE but was not studied as to subject matter.

Problems brought before the Commission.—Intended procedure in work of the Commission utilizing the case method is as follows. A geologist or group of geologists prepares statement of a problem involving a principle or principles of stratigraphic classification, of nomenclature, or of classification and nomenclature, and transmits this statement to the chairman of the Commission. Interpretation of some rule or rules in the Code perhaps is involved.

If the problem involves *questions of fact* (such as equivalence or lack of equivalence of certain beds) on which answer depends, the chairman probably will return the problem to the sender, explaining that the case is inappropriate for review by the Commission.

If the problem seems to be an appropriate one, the chairman will multigraph the statement and furnish a copy to each Commissioner, requesting prompt vote for acceptance or rejection of the problem as an item on the Commission's docket.

As soon as a majority of the Commissioners indicate willingness to review the problem, arrangements for publication of the statement pertaining to it will be made, so that geologists generally may be made aware of the problem and of the Commission's intended deliberation on it. Discussion will be invited for transmittal through the office of the chairman to Commissioners, and, if desired, contributors may at the same time offer their discussion for publication.

Within reasonable time the Commission will formulate its judgment, entering it in the record as a published Opinion, Declaration, or Recommendation. These formal statements by the Commission will be serially numbered and dated for reference. This procedure may seem unnecessarily slow and ponderous, but present judgment of the Commission indicates that advance publication of problems is very desirable, and it is deemed better to proceed as surely as possible rather than too speedily.

Desired organization in statement of a problem.—The Commission expressly announces its intention to exercise the option of receiving a problem for consideration or rejecting such consideration, but actions to receive or reject will be guided by judgment of the manner and extent of development of principles that may be involved. The objective of clarifying our concepts of essential stratigraphic elements and stabilizing our procedure in classification and nomenclature of units has greater importance than means used in work-

ing to this end. Nevertheless, such features as clarity, conciseness, adequacy of statement, and, in judgment of the Commission, general uniformity of organization are extremely desirable attributes of any questions or propositions formally brought before the Commission. The intent to publish these matters as they are presented is in itself sufficient reason to lay stress on organization. In general, convenience to a reader in being led as immediately as possible to essentials of any case seems paramount. Pertinent supplemental statements of fact and argument may be explored in whatever detail desired. In line with this approach, it is suggested that framing of basic statement of any problem be confined to approximately two pages of double-spaced typescript and that all necessary additional writing, such as detailed descriptions, citation of historical data, arguments, and references, be organized in a supplement or supplements, which can be tied by cross index in flexible manner to the basic statement as desired.

Suggested main divisions of the basic statement are the following: (1) Summary, (2) Statement of problem. (3) Observations pertinent to the problem, (4) Conclusions, and (5) Recommendations. The supplement or supplements that normally will be required if the basic presentation of a problem is given in most concise terms may be organized in any appropriate way and need have no specified limit in length. Presentation of data in graphic form, such as sections, correlation charts, and diagrams, is highly desirable. An ideal organization of a problem might be conceived as one that offers in its Recommendations a statement disposing of the problem in phraseology that could be adopted by the Commission by simple act of voting to accept.

Committee of the Cordilleran Section, Geological Society of America.—As medium for developing consensus of judgments of interested West Coast fellows of the Geological Society of America on matters coming before the American Commission on Stratigraphic Nomenclature or on subjects deemed suitable for reference to the Commission, a committee has been appointed by chairman VINCENT P. GIANELLA of the Cordilleran Section, G. S. A. This committee is composed of S. W. MULLER, chairman, U. S. GRANT, IV, J. C. HAZZARD, R. M. KLEINPELL, E. D. MCKEE, C. E. WEAVER, and H. E. WHEELER. Meetings of the committee have been scheduled at Stanford University, April 11, 12, 1947.

REFERENCES

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HOWE, H. V., 1933, "Review of Tertiary Stratigraphy of Louisiana," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 17, pp. 613–55 (see p. 613).

Prepared for the Commission by RAYMOND C. MOORE, *chairman*

NOTE 2—NATURE AND CLASSES OF STRATIGRAPHIC UNITS[1]

AMERICAN COMMISSION ON STRATIGRAPHIC NOMENCLATURE

The following statement concerning the nature and classes of stratigraphic units and supplemental discussion has been submitted by Raymond C. Moore to the American Commission on Stratigraphic Nomenclature as basis for pronouncements by the Commission. Expressions of opinion on this subject are invited from interested geologists in the form of communications to the Commission through its chairman, and, if desired by contributors, discussions may be offered for publication. The subject matter here brought forward is judged to call for specially thorough study before action on it is taken by the Commission. For example, Commissioner H. D. Miser qualified his vote for acceptance of this problem by the condition that decisions should not be formulated hastily and he thought that approximately one year should be stipulated as requisite period for study and discussion.

SUMMARY

1. Three categories of stratigraphic units are defined: (a) *time units*, consisting of divisions of geologic time, (b) *time-rock units*, comprising divisions of rocks segregated on the basis of defined time spans, and (c) *rock units*, composed of rocks having distinctive objective characters, not delimited in any way on the basis of time relations. Names of corresponding time units and time-rock units are identical and consist of adjectives, mostly ending in *an* or *ian* (examples, Permian Period, Permian System). Names of rock units are nouns formed by combining a place name with a lithologic or classificatory rock term (example, Pierre shale, Carbondale formation). Recommendations are made to adopt procedures facilitating sharp discrimination of time and time-rock units on the one hand from rock units on the other.

STATEMENT OF PROBLEM

2. Disagreement in the thinking of many geologists on how to classify and name stratigraphic units seems to originate mainly from vagueness of concepts and differing interpretation of their various categories. The problem is presented of framing in simplest terms a satisfactory statement of the nature and classes of stratigraphic units.

OBSERVATIONS PERTINENT TO PROBLEM

3. All geologists are familiar with division of geologic time into adjoining successive parts called eras, and subdivisions of these in similar manner into segments called periods; in turn, periods are composed of major units termed epochs. These are *time units*. Some geologists think that placement of boundaries between successive time units is measurably arbitrary or at least defined fortuitously, whereas others judge that these boundaries reflect significant punctuation points in earth history and hence are natural (Suppl. 11–16).

4. Geologists are equally familiar with major segmentation of the geologic column in parts corresponding with the time units. These parts comprise (a) rocks formed during an era, (b) rocks, called system, formed during a period, and (c) rocks, called series, formed during an epoch. These are *time-rock units* in that they consist of rocks and their span is

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defined by time. Stage is a time-rock term next below series in rank and as such is almost universally recognized (Suppl. 17–24).

5. Rocks of each class—igneous, sedimentary, metamorphic—are divisible into geographically restricted masses characterized by distinctive lithology and structural relations. These are *rock units*. Despite the fact that time is involved in making rock, definition of such rock units in no way depends on time concepts. Rock units are the basic physical elements for most geologic mapping, description, and notation of mineral and fossil occurrences. Kinds and abundance of fossils, minerals, and other objective features are commonly useful in distinguishing rock units, which include entities of differing rank called group, formation, member, lentil, tongue, and bed (Suppl. 25–27).

6. Names of corresponding time units and time-rock units are the same (e.g., Devonian Period, Devonian System), distinction in usage being indicated by context. This category of names comprises adjectives variously ending in -ian, -ic, -ous, -ary, and -ene. Names of rock units are mostly different from those of any time unit or time-rock unit. Rock unit names are nouns derived from a place name combined with a lithologic term or a rock unit classificatory term, except that in Europe and elsewhere some rock units bear non-geographic names.

CONCLUSION

7. The main source of difficulty in making a consistent, thoroughly sound approach to classification and nomenclature of stratigraphic units as a whole is prevalent failure by geologists to exclude concepts of time from consideration of the objective data on which alone properly defined rock units are differentiated. Recognition of essential distinctions in the nature of time units, time-rock units, and rock units is needed as basis for satisfactory stratigraphic classification and terminology.

RECOMMENDATIONS

8. Publication by the Commission of the following Declaration is recommended.

Nature and classes of stratigraphic units.—Precision in classification and nomenclature of rock units demands recognition of three classes of stratigraphic units, as follows.

a. *Time units*—divisions of geologic time.
b. *Time-rock units*—divisions of rocks segregated on the basis of their relation to determined segments of geologic time.
c. *Rock units*—divisions of rocks segregated on the basis of objective characters deemed to have significance in classification; differentiation not based on time relations.

Each class comprises units of differing magnitude. Nomenclature of time and time-rock units is parallel and employs adjectival names; nomenclature of rock units is independent of other units and employs nouns as names. In no case should the same name be employed for all three categories of units, although they may correspond in derivation.

9. Endorsement by the Commission of the following Recommendation to geologists is advocated.

Nomenclature of stratigraphic units.—For the purpose of emphasizing essential distinctions between stratigraphic units defined by geologic time (time units, time-rock units) from those based on lithologic and structural features (rock units), which are independent of geologic time, it is recommended that

a. Names of time and time-rock units shall consist of adjectives generally formed by addition of addition of the ending -ian or -an to a geographic name (examples, Cincinnatian Epoch, Canadian Series).
b. Classificatory terms of time and time-rock units, when used with the names of these units, shall employ an initial capital letter (examples, Devonian Period, Devonian System, Erian Epoch, Erian Series).
c. Names of rock units shall consist of nouns formed by combining a place name with a lithologic or classificatory rock unit term, in accordance with existing practice (examples, Tuscarora sandstone, Milford granite, Tejon formation, Montana group).
d. Classificatory terms of rock units shall employ initial lower-case letters, in accordance with current American practice but differing from common British custom (examples, Maquoketa shale, Leavenworth limestone member).

10. Modification of Section I of the Stratigraphic Code to incorporate features of foregoing paragraphs is recommended.

SUPPLEMENT

DISCUSSION OF TIME UNITS

11. Geologic time units can not be defined directly and exactly because no means have been found for measuring their span in years or for marking their boundaries precisely. This statement may give insufficient weight to varve studies, but if so, the generalization is not modified significantly. The radioactive time scale affords a few reasonably well checked age determinations, provided we allow latitude of a few million years in the calculations, yet radioactive measurements probably never can be applied to fixing the beginning and end points of a geologic period or epoch. Geologic time units, therefore, are determined indirectly and somewhat indefinitely. It is important to remember that definition of time units is based on study of divisions of the geologic column classed as time-rock units.

12. Geologic time is continuous, and it is customary to think that time units neither offlap nor overlap those adjoining them; they divide time like markings for hours and minutes inscribe the face of a clock. Time units of large magnitude are divided into lower-rank units that adjoin so as to fill the span of the large units. Clearly, this is a rather theoretical procedure that presents numerous difficulties in practical application to geochronology. If time units could be defined in terms of an uninterrupted succession of time-rock units occurring in a single region, these might be judged to be complete and accordant. If the time units are based on time-rock units occurring in different regions, however, as is generally the case, question arises as to the interrelation of their respective spans.

13. The prime objective of time-unit classification is formulation of a framework that may serve adequately as foundation for accurate and complete recording of successive conditions and events in geologic history. This objective conceivably may be attained by definition of time units differently in separate regions but it is then necessary to correlate the differing sets of time units in order to obtain an integrated historical account. It is natural—perhaps inevitable—that time units of rank below period should be only regional in scope until solid ground for modifying and extending their applicability has been gained. Thus, it is judged that subordinate time units may have to be set up varyingly in different continents and provinces. This divergence in some regions may even extend to definition of periods (e.g., Karroo Period, Kamilaroi Period), but it is to be hoped that ultimately a single set of geologic periods will be recognized throughout the world.

14. Time units that by definition overlap or offlap adjacent units of the same rank seem to be unnecessary and undesirable (Hedberg, in Schenck *et al.*, 1941, p. 2204). They are a source of confusion rather than clarification of geologic history.

15. The use of different classificatory terms (as chron, age, phase, hemera) for time units lower in rank than period is judged to be unnecessary, cumbersome, and otherwise objectionable. The term epoch may be employed without confusion for all time unit of sub-period rank.

16. The names of time units are desirably the same as those of time-rock units, for these categories are closely interrelated, definition of the former depending on the latter. The names of geologic periods are fairly well established but those applied to subdivisions of periods vary considerably and are not yet widely in agreement.

DISCUSSION OF TIME-ROCK UNITS

17. The concept of time-rock units differs fundamentally from that of rock units inasmuch as the boundaries of time-rock units are defined by selected horizons presumed to represent as precisely as possible corresponding points in geologic time, whereas the

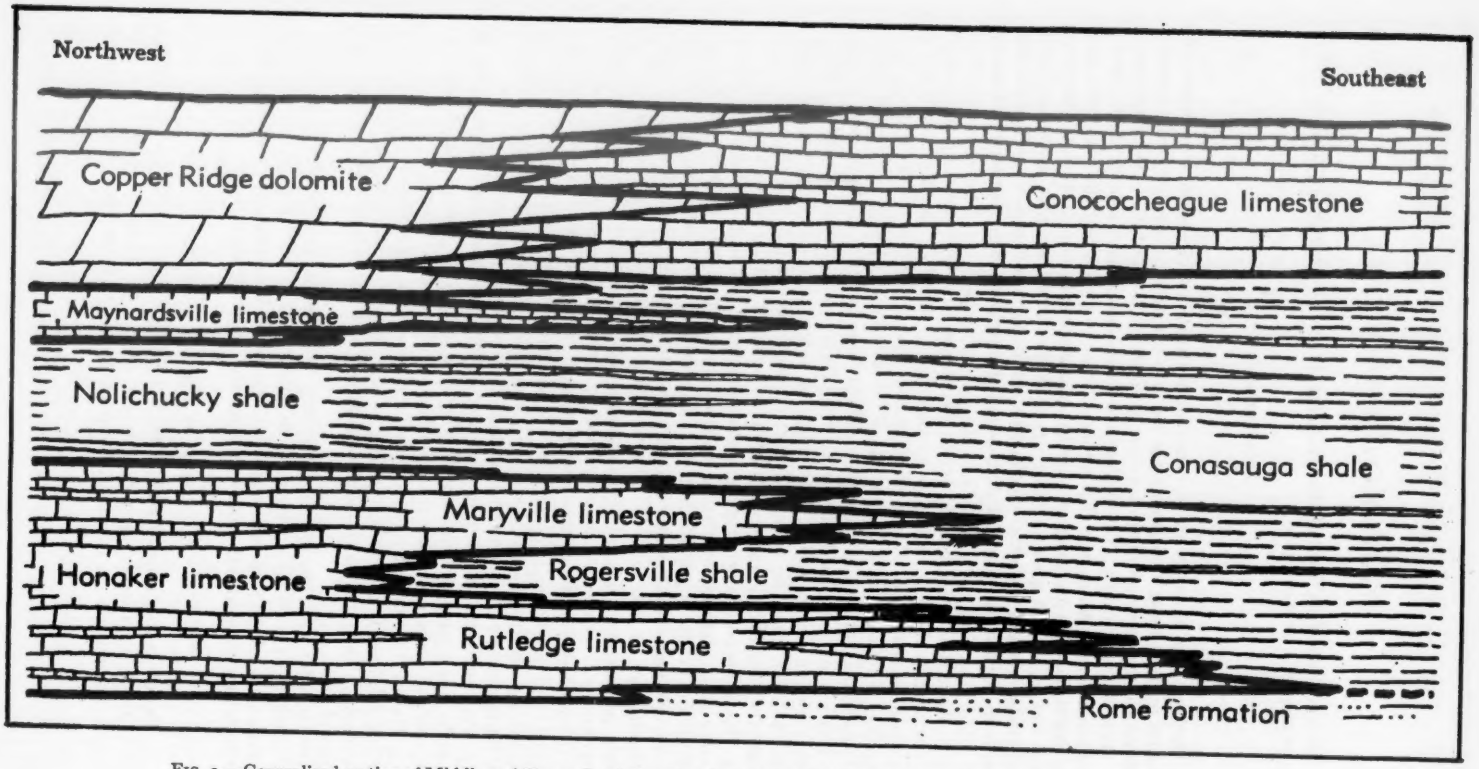

FIG. 1.—Generalized section of Middle and Upper Cambrian deposits in Appalachian region near the Virginia-Tennessee boundary, showing interrelations of named rock units (modified from Howell *et al.*, 1944).

boundaries of rock units are not defined in such terms and frequently transect time lines. The time-rock units differ from time units in that the former consist of rocks.

18. Depending on the magnitude of time span represented, and the recognized geographic extent of given time-rock units, they may incorporate all or part of many rock units defined by lithology. The essential basis for differentiation of time-rock units is the nature and distribution of fossils. The boundaries of time-rock units may or may not be clearly defined in field study, and they may or may not be adapted for representation readily on a geologic map. Examples of time-rock units concerning which nearly all geologists agree are the geologic system and series. The boundaries of systems and series in many places coincide with unconformities, but in areas of continuous sedimentation the common boundary of contiguous time-rock units must be defined in terms of a selected marker or markers among the fossils present.

19. Examples of systems and series are familiar to all. The names of the prevailingly recognized geologic systems are varied in origin and are neither uniform in signification or word ending. Some are directly or indirectly based on geographic features, some on prominent physical attributes of the rock succession in type regions, and some merely on relative position in the geologic column. All systemic names are adjectives, however, having endings in *ian, ic, ous, ary,* or *ene;* if used as substantives, the word "system" or "rocks" is understood. This adjectival form, supplemented by habit from long training and thinking, leaves no geologist in doubt at any time concerning the inherent connotation of geologic time that is embraced in systemic terms, yet each geologist clearly understands that in speaking, writing, or reading about a geologic system, he is concerned with rocks. The unit consists of rocks but the yardstick for measuring the span and determining the limits of the unit is geologic time.

20. Statements of the foregoing paragraph apply to the term series, but only with qualifications, because actual usage is lacking in uniformity. Geologists agree that a series is a primary division of a system, and that, like system, it comprises rocks set apart on the basis of time boundaries. They do not now agree that these primary divisions have interregional or inter-continental applicability and they are not united in judgment concerning criteria for defining them or naming them. Some think that both system and series are measurably arbitrary divisions of the geologic column that have been established more or less fortuitously because they are based mainly on observations in Europe where geologic science happened to have foundation and first growth; such time-rock divisions are necessary, according to these geologists, but other units than the ones we have would probably serve about as well. Others think that system and series reflect significant physical events or changes on the earth's surface in the course of geologic history, and they hold that with aid of paleontological evidence a natural time-rock classification having widespread applicability is attainable. According to either view, there is a tendency to consider systems as made up of not more than two or three series, which generally are designated as Lower and Upper, or Lower, Middle, and Upper; the scientific basis for such two- or three-fold limitation of series in a system seems unsound.

21. Time-rock terms other than system and series have not been recognized generally or used consistently, although workers outside of North America during more than a half-century have established firmly the usage of stage as a time-rock term comprising a first-order division of series. Many substages also are defined. There is increasingly prevalent acceptance of stage by American geologists.

22. The relation of time-rock units to rock units can be apprehended most clearly by study of diagrams showing the two kinds of units together. Examples, selected more or less at random, are given here—one representing Cambrian units in part of the Appalachian region (Figs. 1, 2) and another depicting Upper Cretaceous units in part of the Texas region (Fig. 3). Both are based on recently published correlation charts prepared by

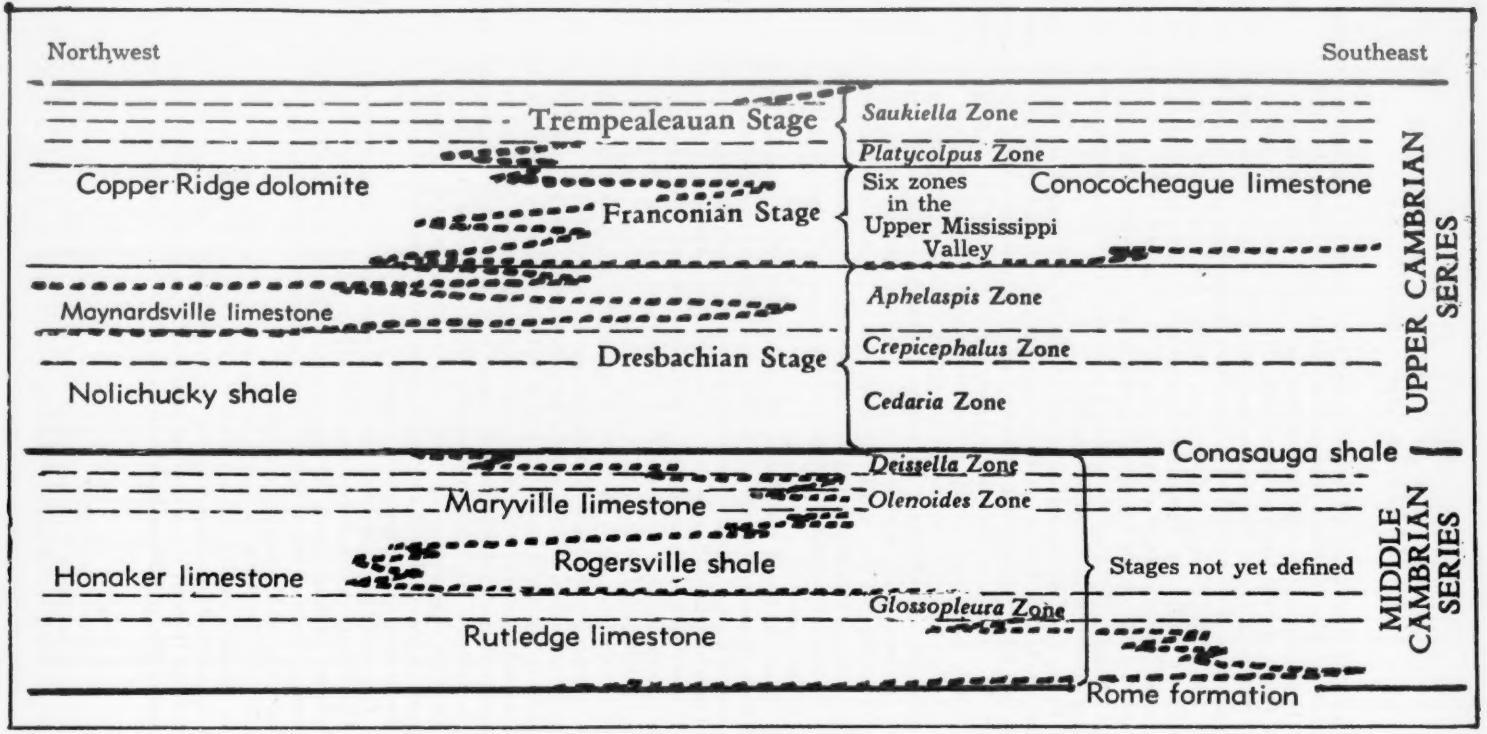

FIG. 2.—Diagram showing time-rock units differentiated in section illustrated in Figure 1 (data from Howell *et al.*, 1944).

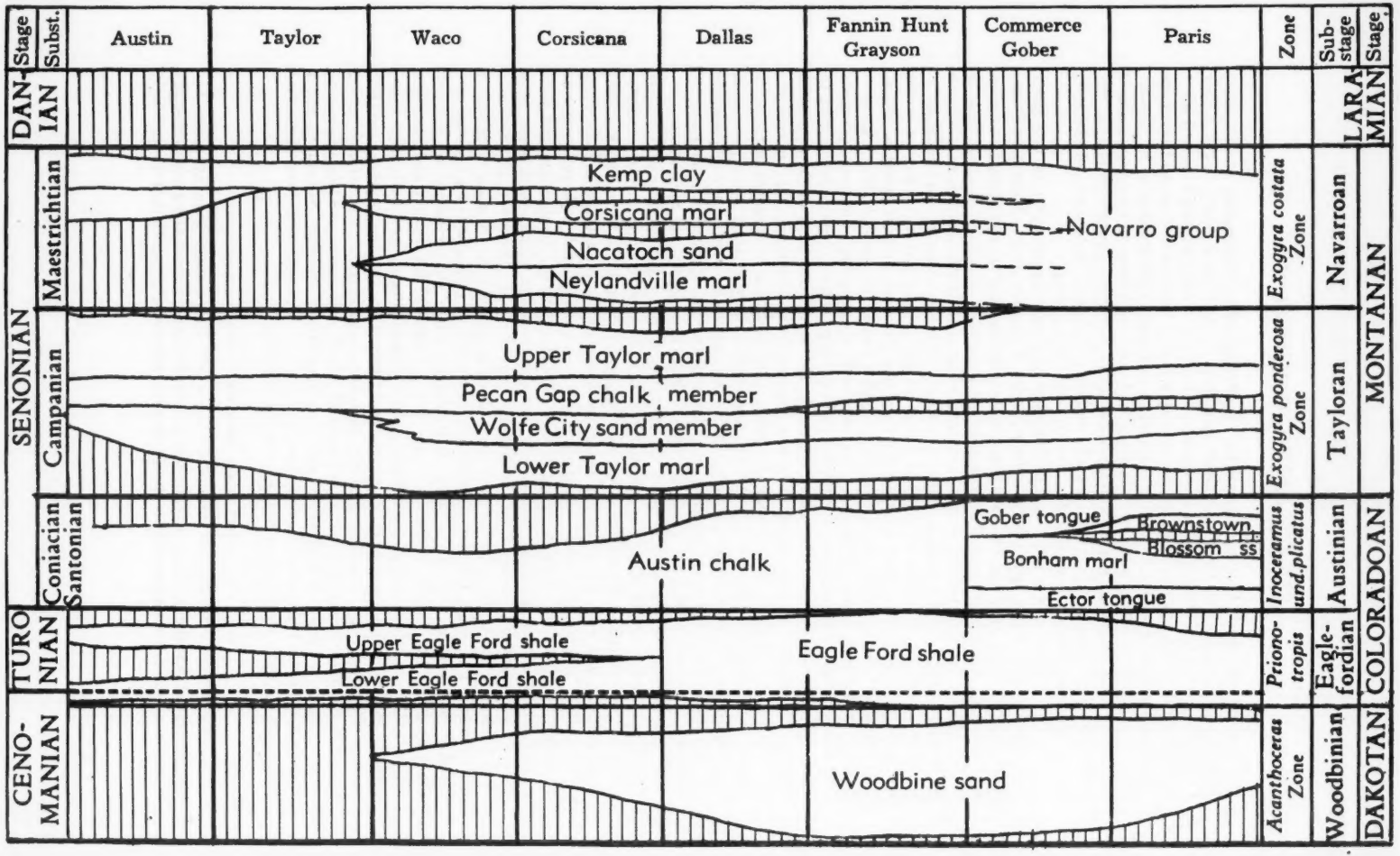

FIG. 3.—Correlated sections of Upper Cretaceous rocks in part of Texas region showing hiatuses (vertical ruling) between various rock units and indicating time-rock units (modified from Stephenson *et al.*, 1942; time-rock classification at right by Moore).

the National Research Council Committee on Stratigraphy (Stephenson *et al.*, 1942; Howell *et al.*, 1944). The Cambrian chart recognizes three named stages in the Upper Cambrian Series and defines numerous zones, which are really substages named after characteristic fossil genera. The Cretaceous chart shows European stage and substage divisions, but names of American time-rock units in Figure 3 are introduced by Moore. Lack of parallelism between the boundaries of rock units and those of time-rock units is evident in both diagrams. Hiatuses indicated in the Cretaceous diagram emphasize the point that the Navarroan time unit (Epoch) and time-rock unit (Substage), for example, are by no means synonymous with the Navarro rock unit (group).

23. The uniform use of adjectival designations and capitalization of time and time-rock classificatory terms (as Upper Cambrian Series, Canadian Series, Montanan Stage, Tayloran Substage) are judged to have much more importance than may appear on casual first thought. Their importance lies in furnishing invariably definite indication that all such terms are basically defined by time concepts, whereas other stratigraphic names (such as Montana group, Taylor marl, Austin chalk, Conococheague limestone, and multitudinous others) are not delimited in terms of time. One may argue that use of the *an* or *ian* endings and a capitalized class term for the time and time-rock units is purely a device, that adjectival words derived from some stratigraphic names (for example, Black River—Blackriveran, Finger Lakes—Fingerlakesian) are peculiarly awkward or even cacophonous and that writing of Period, System, etc. with an initial capital letter is entirely contrary to habit. These things are true. The scientific gain derived from acceptance of the proposals, however, is thought to more than offset any suggested disadvantages. We are well accustomed to use of *ian* and *an* endings for many time and time-rock names but not for others. Familiarity with the latter is likely to come rapidly once we start to use them. It is suggested that wherever possible time and time-rock names be written as mononomials (as Desmoinesian, not Des Moinesian) and that euphony is improved in some cases by adoption of *an* rather than *ian* as adjectival ending (as Springeran, not Springerian).

24. KLEINPELL (1938, p. 91), SCHENCK (1941, p. 2201) and other California geologists have advocated complete duality of nomenclature so as to avoid confusion between cartographic (rock) units and chronologic (time and time-rock) units. Thus, the names Relizian, Saucesian, Luisian, etc., introduced to designate stages in the West Coast mid-Tertiary section, differ in derivation from the names of any rock units. If such rock unit names as Monterey, Temblor, and Rincon were modified into Montereyan, Temblorian, and Rinconian, for use as time and time-rock names, geologists working with these deposits have judged that confusion, rather than clarification, would result. Moreover, lithologically defined units in many places do not coincide at all with desired limits of stage divisions. A little study of California Tertiary stratigraphy, or merely an inspection of a regional correlation chart such as that of the National Research Council subcommittee on Tertiary (Weaver *et al.*, 1944) serves to persuade one that the views of KLEINPELL and SCHENCK are well taken in stressing need for complete separation of time-defined units from lithologically defined units. In most other regions and parts of the geologic column, however, no such difficulty exists. Generally speaking, therefore, no valid reason is seen for objecting to use of the same geographic name as source of a rock unit name (as Colorado group, Austin chalk), a time-rock unit name (as Coloradoan Stage, Austinian Substage), and a time unit name (as Coloradoan Epoch, Austinian Epoch). The adjectival form of the two latter sorts of units clearly identifies their time connotation.

DISCUSSION OF ROCK UNITS

25. Experience of geologists throughout the world during more than 150 years has demonstrated that the most essential first step in undertaking almost any geological study is observation of the nature and relations of rock masses. Differentiation of seemingly

significant divisions or units of the rocks is required for geological mapping, description, definition of structural relations, notation of the occurrence of fossils or mineral deposits, and similar purposes that serve economic utilization and conduce understanding of geologic processes and history. Methods of defining, naming, and classifying these units have varied widely but nearly everyone recognizes that the prime requisite of differentiation is physical objectivity. The boundaries of a given rock unit should be surfaces marking the sharpest change from characters that distinguish the unit to those of adjoined units. Such boundaries, if clearly marked, are likely to be drawn similarly by all geologists, and. if defined by one geologist, they can be recognized and confirmed by others. Thus, a widespread thick-bedded sandstone of uniform lithology, resting unconformably on various older rocks and overlain by shale, would probably be differentiated as a rock unit in approximately identical manner by any geologist. On physical and structural grounds the sandstone is clearly set apart from associated rocks. Likewise, a granitic mass or an area of schistose rocks, each characterized by common physical features, origin, and structural relations to adjoining rocks, may comprise natural rock units in the sense here discussed.

26. Attention is drawn especially to the point that rock units, defined by lithologic characters and structural relations, in no way depend on the yardstick of geologic time. That is to say, concepts of geologic time spans properly play no part in differentiating or determining the boundaries of any such rock unit. It is true that relatively short or long fragments of geologic time are involved in making each rock unit—sedimentary, igneous, or metamorphic—but this fact is irrelevant to recognition of the unit. Study of most lithologically differentiated units indicates conclusively that parts belonging to the units in different places do not represent precisely the same time span (Figs. 1, 2). The making of rock that is assigned to the unit began earlier in some localities than others, and it may have ended sooner or lasted longer in various places; also, removal of rock material by erosion may reduce the span of the unit from its original value. The entire thickness of an overlapping sand body, for example, may be geologically younger in some areas than the entire thickness of the same body in others. Accordingly, it is judged that definition of rock units is entirely independent of time concepts and that the common tendency of geologists to think of rock units in terms of time is a source of much confusion.

27. Rock units comprise masses termed groups (as, Trinity, Mesaverde, Montana), formations (as Utica shale, Viola limestone, Meganos formation), members (as Plattsmouth limestone member, Ironton sandstone member, Montauk till member), lentils (as Horse Bench sandstone lentil, Franklindale limestone lentil), tongues (as Gober tongue of Austin chalk, Satan tongue of Mancos shale), and the like. The examples cited are sedimentary rock units. Igneous rock units are differentiated and named similarly (as Pikes Peak granite, Minidoka basalt, Huerto andesite, Ogima amygdaloid, Ulupau tuff, Casto volcanics). Metamorphic rock units are also readily illustrated by examples (as Hoppin slate, Manhattan schist, Northbridge granite gneiss, Taylor meta-andesite, Tufts quartzite member, Cockeysville marble). All these rock units—surface and subsurface—have utmost variation in physical constitution, thickness, and structural relations, but most of them are sheetlike tabular bodies. All are characterized by limited geographic distribution and all are distinguished by objectively determinable boundaries.

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Prepared for the Commission by RAYMOND C. MOORE, *chairman*

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGIST
VOL. 31, NO. 3 (MARCH, 1947), PP. 529-532

REVIEWS AND NEW PUBLICATIONS

* Subjects indicated by asterisk are in the Association library, and are available, for loan, to members and associates.

OIL FOR VICTORY, BY THE EDITORS OF *LOOK*

REVIEW BY JOHN L. FERGUSON[1]
Tulsa, Oklahoma

**Oil for Victory*, by the Editors of *Look*. 287 pp., including index and 203½ pp. of illustrations. McGraw-Hill Book Company, Inc., New York (1946). Price, $3.50.

This briefly told story of the part which American oilmen played in World War II follows the general literary style of *Look* magazine, which features a multiplicity of pertinent and striking photographs linked together with sufficient text to give the story continuity. Of the 270 pages of material, 203½ pages are devoted to illustrations. Each of the twelve chapters averages 22½ pages, 18 of which are taken up by photographs with descriptive material and the remaining 4½ pages are given over to the subject matter under consideration.

The book opens with a chapter establishing the pre-eminent importance of petroleum in war, and then proceeds chapter by chapter to depict the activities of all branches of the oil industry in meeting the needs of the United States military forces by greatly expanded efforts in discovery, manufacture, and transportation of petroleum and its products.

Chapter 10, entitled "Searchers in Far Places," covers the contributions of geologists and geophysicists in 3½ pages of text and 12½ pages of pictures, including an exposition of the origin of oil, the old and new exploration practises and the extent and future of American exploration. Chapter 11, entitled "Tundra, Sea and Jungles," indicates the areas where future exploration for petroleum foi American industry and defense must be prosecuted.

Oil for Victory is unique among the recent attempts to popularize the oil industry by virtue of its numerous well selected illustrations.

[1] Amerada Petroleum Corporation. Review received, January 28, 1947.

1945 REFERENCE REPORT ON CERTAIN OIL AND GAS FIELDS OF NORTH LOUISIANA, SOUTH ARKANSAS, MISSISSIPPI, AND ALABAMA

REVIEW BY E. FLOYD MILLER[1]
Tulsa, Oklahoma

1945 Reference Report on Certain Oil and Gas Fields of North Louisiana, South Arkansas, Mississippi, and Alabama, Vol. 1. 328 pp., 1 p. correlation and nomenclature, 3 pp. correlation charts, 3 pls. of regional cross sections. 8.5×11 inches. Heavy manila cover, plastic ring-type binder. Published by Shreveport Geological Society, Box 750, Shreveport, Louisiana. Price, $12.50 per copy.

This publication may well, and justly so, be considered a bible of the oil geology of the area covered. In its 328 pages of descriptive data and structural geologic maps, with as-

[1] A. G. Oliphant. Review received, February 3, 1947.

sociated correlation charts, stratigraphic cross sections, and geographical index maps, the authors have compiled a monumental volume.

The initial work on this reference report was commenced in 1944 and was continued until its final publication in December, 1946. Adverse conditions, due to the war, caused many delays, and the members of the Shreveport Geological Society are to be congratulated for all their untiring and unselfish efforts expended in compiling such a wealth of information.

As a preface to the Report, the Notes on Correlation and Nomenclature outline the stratigraphic units of the Upper Cretaceous, Comanche, and Jurassic ages with their regional correlations in the Coastal Plain of Texas, Arkansas, Louisiana, Mississippi, and Alabama. In the correlation charts one will find many new names and correlations which will afford the basis of future arguments. The reviewer withholds his judgment on the matter.

The Report may be roughly divided into three major parts: one describing the oil and gas fields in Sough Arkansas; one, the oil and gas fields of North Louisiana; and the last, the oil and gas fields of Mississippi and Alabama. In South Arkansas 17 fields are described; in North Louisiana 31 fields; in Mississippi 16 fields; and one field in Alabama. The oil and gas fields, by states, are indexed in the front of the book. Their geographical location may be found by referring to an additional index, accompanied by the index map in the last few pages of the Report.

Each oil and gas field is amply described under the following headings: (1) Location, (2) Pre-Discovery Data, (3) Discovery Well (or Wells), (4) Structure, (5) Producing Zones, (6) Well Spacing, (7) Well Allowable, (8) Development, (9) Deepest Well in Field, (10) Proven Area, (11) Production Statistics, (12) Miscellaneous Data, (13) Pipe Line Outlets. To accompany this is a structural contour map of the field, superimposed on a base lease map of the area, and stratigraphic or structural cross section of the field, compiled from electrical logs. In some cases only a type electrical log of the field is shown, but in these as well as in the cross sections the stratigraphic units are identified.

The three plates of regional cross sections, compiled from electrical logs, in the back of the Report, give an excellent example of the many stratigraphic and structural problems of the province.

In addition the authors have compiled an excellent index to the oil and gas fields, and salt domes of South Arkansas, North Louisiana, Mississippi, Alabama, and East Texas with an index map showing the geographic location of the fields.

In conclusion, the authors are to be commended upon the clear, concise treatment of all the pertinent data regarding the various oil and gas fields and upon the excellent drafting of all the maps and cross sections. Many of the oil fields described in this Report are new and of national importance,—and from these data numerous new papers for the American Association of Petroleum Geologists should be written.

RECENT PUBLICATIONS

ALABAMA, GEORGIA, FLORIDA

"Regional Subsurface Stratigraphy and Correlation of Middle and Early Upper Cretaceous Rocks in Alabama, Georgia, and North Florida," by Paul L. Applin and Esther R. Applin. *U. S. Geol. Survey Prelim. Chart 26*, Oil and Gas Investig. Ser. (January, 1947). 3 sheets, each 40×44 inches. 5 stratigraphic sections, 5 structure sections, 3 paleogeographic maps, 2 structure-contour maps, thickness map, table of nomenclature, explanatory text. For sale by Director, Geological Survey, Washington 25, D. C. Price, $0.90 (set of 3 sheets).

ARGENTINA

*"Contribución al conocimiento geológico del Neuquén extraandino" (Contribution to the Geology of the Territory of Neuquén), by Abel Herrero Ducloux. *Bol. Inform. Petroleras*, Vol. 23, No. 266 (Y.P.F., Buenos Aires, October, 1946), pp. 245–81; 8 figs., 1 geological map. Regional geology, stratigraphy, and structure; bibliography. In Spanish.

CALIFORNIA

*"Coalinga Oil Field," by E. J. Kaplow. *California Oil Fields*, Vol. 31, No. 2 (San Francisco, July–December, 1945 (1946), pp. 5–22; 6 pls., 6 tables. History, drilling and production practice, subsurface conditions, and possibilities of deeper production and secondary recovery in one of the oldest fields in California. California Dept. of Nat. Resources, Div. of Oil and Gas.

CANADA

*"Searching for Petroleum in the Maritimes," by Donald J. MacNeil. *Erg. Jour.* (Montreal, Canada, October, 1946), pp. 1–4; 2 photographs.

*"Major Canadian Development Seen in the Lloydminster Area," by F. H. Edmunds. *Oil Weekly*, Vol. 124, No. 6 (Houston, January 6, 1947), pp. 16–20, International Section; 2 figs., 1 photograph. Lower Cretaceous production from 36 wells in field on Alberta-Saskatchewan border, 300 miles north of international boundary.

GENERAL

*"Controlled Directional Drilling of Wells, Part 1," by G. L. Kothny. *Oil Weekly*, Vol. 124, No. 8 (Houston, January 20, 1947), pp. 30–33; 14 figs.

*"Quick Freezing of Cores Preserves Fluid Contents," by John D. Wisenbaker. *Oil Weekly*, Vol. 124, No. 8 (January 20, 1947), pp. 42–46; 6 figs., 5 tables. Permeability and porosity measurements made on consolidated sand cores, selected from various oil fields, before and after quick freezing.

When the Oil Wells Run Dry, by Walter M. Fuchs. xiv+430 pp., 79 figs., 13 tables. Guide book presenting an integrated picture of oil, including social, political, and scientific oil facts. Industrial Research Service, Dover, New Hampshire (1946). Price, $3.75.

*"Principle Uses of Fluorlogs," by Orton E. Campbell. *Oil Weekly*, Vol. 124, No. 5 (December 30, 1947), pp. 41–45; 2 figs. New technique uses well cuttings; based on principle that rocks overlying oil accumulation are characterized by anomalously high fluorescent intensity.

*"Fault Problems in Fault Planes," by R. H. Beckwith. *Bull. Geol. Soc. America*, Vol. 58, No. 1 (New York, January, 1947), pp. 79–108; 19 figs. Fault problems are treated by sections in fault planes; several methods are given for determining pitch, and apparent thickness; examples include transverse faults cutting folds.

Dictionnaire Technique des Termes du Petrole en Francais, Anglais, Russe, Allemand (Glossary of Technical Terms of the Oil Industry published in French, English, Russian, and German), 2nd edition. 488 pp. 3,000 terms arranged in alphabetical order in English, adjacent columns giving corresponding terms in the 3 other languages. Published by Groupe Français du Conseil de Contrôle Mission des Carburants (Berlin, 1946). For sale by l'Association Française des Techniciens du Pétrole, 44, Rue de Rennes, Paris (6e). Price, 400 francs.

GULF COAST

*"Oil Possibilities on the Gulf Coast Continental Shelf," by James S. Critz. *Oil Weekly*, Vol. 124, No. 6 (January 6, 1947), pp. 17–21; 5 figs., 1 table. Geological setting; exploration activity; ownership problem.

ILLINOIS

"King Oil Field, Jefferson County, Illinois," by Stewart H. Folk and David H. Swann. *Illinois Geol. Survey Rept. Inv. 119* (Urbana, February, 1947). 27 pp., 8 figs. Price, $0.25.

KANSAS

*"Cretaceous Stratigraphy of the Belvidere Area, Kiowa County, Kansas," by Bruce F. Latta. *Kansas Geol. Survey Bull. 64*, Part 6 (Lawrence, December, 1946), pp. 217–60; 3 pls., 4 figs. Type area for Comanche series of Early Cretaceous age as developed in Kansas.

TEXAS

*"Stratigraphy of the Upper Cambrian, Llano Uplift, Texas," by Josiah Bridge, Virgil E. Barnes, and Preston E. Cloud, Jr. *Bull. Geol. Soc. America*, Vol. 58, No. 1 (New York, January, 1947), pp. 109–24; 8 pls. Description of the 8 members of the Riley and Wilberns formations, with correlated, columnar sections based on 19 measured sections.

WEST VIRGINIA

*"Expanding Frontiers of Natural Gas in West Virginia," by David B. Reger. *Oil Weekly*, Vol. 124, No. 8 (January 20, 1947), pp. 36–39; 1 map, 1 columnar section. History of development; expansion of production both laterally and vertically; Ordovician possibilities unknown, inadequately tested.

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Elected In	*At*	*President*	*Vice-President*[1]	*Secretary-Treasurer*[2]	*Editor*[3]
1917	Tulsa	J. Elmer Thomas	Alex. Deussen	M. G. Mehl	C. H. Taylor
1918	Oklahoma City	Alex. Deussen	I. C. White[4]	W. E. Wrather	C. H. Taylor
1919	Dallas	I. C. White[4]	Irving Perrine	C. E. Decker	C. H. Taylor
1920	Dallas	W. E. Pratt	Alex. W. McCoy[6a]	C. E. Decker	R. C. Moore
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1924	Houston	J. H. Gardner	E. G. Gaylord	C. E. Decker	R. C. Moore
1925	Wichita	E. L. DeGolyer	R. S. McFarland	C. E. Decker	R. C. Moore
1926	Dallas	Alex. W. McCoy[6a]	C. R. McCollom	Fritz L. Aurin	J. L. Rich
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1930	New Orleans	Sidney Powers[8]	Ralph D. Reed[9]	Marvin Lee	F. H. Lahee
1931	San Antonio	L. P. Garrett[10]	L. C. Decius	Frank R. Clark	F. H. Lahee
1932	Oklahoma City	F. H. Lahee	R. J. Riggs	W. B. Heroy	R. D. Reed[9]
1933	Houston	Frank R. Clark	George Sawtelle	W. B. Heroy	L. C. Snider
1934	Dallas	W. B. Heroy	E. B. Hopkins[11]	M. G. Cheney	L. C. Snider
1935	Wichita	A. I. Levorsen	F. A. Morgan	E. C. Moncrief	L. C. Snider
1936	Tulsa	Ralph D. Reed[9]	C. E. Dobbin	Chas. H. Row	L. C. Snider
1937	Los Angeles	H. B. Fuqua	C. L. Moody	Ira H. Cram	W. A. Ver Wiebe
1938	New Orleans	D. C. Barton[12]	H. W. Hoots	Ira H. Cram	W. A. Ver Wiebe
1939	Oklahoma City	Henry A. Ley	L. M. Neumann	Ed. W. Owen	W. A. Ver Wiebe
1940	Chicago	L. C. Snider	John W. Vetter	Ed. W. Owen	W. A. Ver Wiebe
1941	Houston	Ed. W. Owen	Earl B. Noble	E. O. Markham	W. A. Ver Wiebe
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1943	Fort Worth	A. R. Denison	R. W. Clark	R. E. Rettger	Carey Croneis
1944	Dallas	Ira H. Cram	W. B. Weeks	R. E. Rettger	Gayle Scott
1945	Tulsa	M. G. Cheney	M. Gordon Gulley	Ed. A. Koester	Gayle Scott
1946	Chicago	Earl B. Noble	D. Perry Olcott	Ed. A. Koester	Gayle Scott

[1] From March 1920, to March, 1932, the corresponding office was *first vice-president*.
[2] From March, 1929, to March, 1932, the corresponding office was *second vice-president in charge of finances*.
[3] From March, 1929, to March, 1932, the corresponding office was *third vice-president in charge of editorial work*.
[4] Died, November 25, 1927.
[5] Died, January 3, 1940.
[6] Died, January 10, 1939.
[6a] Died, June 30, 1944.
[7] Died, July 9, 1943.
[8] Died, November 5, 1932.
[9] Died, January 29, 1940.
[10] Died, December 13, 1943.
[11] Died, July 5, 1940.
[12] Died, July 8, 1939.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
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THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS MEMBERSHIP LIST[1]

MARCH 8, 1947

HONORARY MEMBERS

The Executive committee may from time to time elect as honorary members persons who have contributed distinguished service to the cause of petroleum geology. Honorary members shall not be required to pay dues.—*Sec. 6. Article III, of the Constitution.*

LIFE MEMBERS

The executive committee may grant life membership to members who have paid their dues and are otherwise qualified.—*Sec. 2, Article III, of the Constitution.*

On the payment of two hundred dollars ($200.00) any member in good standing shall be declared a life member and thereafter shall not be required to pay annual dues.—*Sec. 2, Article I, of the By-Laws.*

MEMBERS

Any person engaged in the work of petroleum geology or in research pertaining to petroleum geology or technology is eligible to active membership, provided he is a graduate of an institution of collegiate standing, in which institution he has done his major work in geology, or in sciences fundamental to petroleum geology, and in addition has had the equivalent of three years' experience in petroleum geology or in the application of these other sciences to petroleum geology or to research in petroleum geology or technology; and provided further that in the case of an applicant for membership who has not had the required collegiate or university training, but whose standing in the profession is well recognized, he shall be admitted to membership when his application shall have been favorably and unanimously acted upon by the executive committee, and provided further that these requirements shall not be construed to exclude teachers and research workers in recognized institutions whose work is of such character as in the opinion of the executive committee shall qualify them for membership.

Active members alone shall be known as members.—*Sec. 1, Article III, of the Constitution.*

ASSOCIATES

Any person having completed as much as thirty hours of geology (an hour shall here be interpreted as meaning as much as sixteen recitation or lecture periods of one hour each, or the equivalent in laboratory) in a reputable institution of collegiate or university standing, or who has done field work equivalent to this, is eligible to associate membership, provided at the time of his application for membership he shall be engaged in geological studies in an institution of collegiate or university standing; or shall be engaged in petroleum geology; and any person who is a graduate of an institution of collegiate standing, in which he has done his major work in sciences fundamental to petroleum geology or petroleum technology, and who has had the equivalent of one year's experience in the application of his science to the study of petroleum geology, shall be eligible to associate membership, provided at the time of his application for membership he shall be engaged in investigations in the broader subject of petroleum geology and technology.

Associate members shall be known as associates.

Associates shall enjoy all the privileges of membership in the Association, save that they shall not hold office, sign applications for membership, or vote; neither shall they have the privilege of advertising their affiliation with the Association in professional cards or professional reports or otherwise.—*Sec. 3, Article III, of the Constitution.*

[1] This list is published for the use of the members and for the information of all who wish to refer to the professional and business affiliations of the members. It is not a mailing address list and it is not intended to be used for circularizing or soliciting purposes.

HONORARY MEMBERS

	Date of Election
Darton, Nelson Horatio, 6969 Brookville Rd., Chevy Chase, Md.	Jan. 7, 1938
Decker, Charles Elijah, Univ. of Oklahoma, Norman, Okla.	Mar. 26, 1927
DeGolyer, Everette Lee, 1000 Continental Bldg., Dallas, Tex.	Dec. 8, 1944
Emmons, William H., Univ. of Minnesota, Minneapolis, Minn.	Feb. 28, 1946
Gould, Charles Newton, 215 S. Webster, Norman, Okla.	Oct. 13, 1943
Harris, Gilbert Dennison, Cornell Univ., Ithaca, N. Y.	Mar. 19, 1935
Lahee, Frederic H., Sun Oil Co., Dallas, Tex.	Feb. 15, 1947
Lawson, Andrew Cowper, Bacon Hall, Univ. of California, Berkeley, Calif.	Dec. 22, 1937
Mendenhall, Walter Curran, 9 E. Lenox St., Chevy Chase, Md.	Mar. 19, 1935
Ordonez, Ezequiel, Abraham Gonzalez 79, Mexico City, Mexico	Dec. 28, 1935
Sellards, E. H., Univ. of Texas, Bureau of Economic Geol., Austin, Tex.	Feb. 28, 1946
Stille, Hans, Geol. Inst., Univ. of Berlin, Berlin, Germany	Mar. 15, 1937
Twenhofel, W. H., Univ. of Wisconsin, Madison, Wis.	Oct. 25, 1946
Woolnough, Walter George, c/o W. L. Woolnough, "Calabonna," Park Ave., Gordon, N. S. W., Australia	Mar. 21, 1941
Wrather, William Embry, U. S. Geol. Survey, Washington, D. C.	Oct. 13, 1943

COMPLETE LIST OF MEMBERS, ASSOCIATES, HONORARY MEMBERS, AND LIFE MEMBERS

Honorary	15
Life	14
Members	3,871
Associates	1,144
Total	5,044

EXPLANATION OF SYMBOLS

* Honorary Member. † Life Member. ‖ Associate. Members are not marked. The year refers to the date of election to membership.

Abbey, Gerald Ellsworth, c/o Charles O. Abbey, Rt. 1, Platte City, Mo. '42
‖Abbott, Earl O., Texon Oil & Land Co., 1710 Fair Bldg., Fort Worth, Tex. '46
Abbott, John L., Pritchard & Abbott, Century Bldg., Fort Worth, Tex. '27
‖Abbott, Wayne Rosser, Wood River Oil & Refg. Co., Oklahoma City, Okla. '42
Abell, George T., independent, Box 430, Midland, Tex. '29
Abernathy, George Elmer, Kansas Geol. Survey, Pittsburg, Kan. '38
Abreu, Sylvio Froes, Mineral Industries Div., Av. Venezuela 82, Rio de Janeiro, Brazil, S. A. '45
‖Absher, Kenneth B., independent, Milam Bldg., San Antonio, Tex. '25
Absher, William F., Cities Service Oil Co., Bartlesville, Okla. '20
Acheson, Cyrus Harold, International Ecuadorian Petr. Co., Guayaquil, Ecuador, S. A. '39
Achning, Walter J., independent, Milam Bldg., San Antonio, Tex. '38
Ackerman, Edgar Dumont, Standard Oil Co. of Venezuela, Caripito, Venezuela, S. A. '40
Ackers, A. L., Stanolind Oil & Gas Co., Box 591, Tulsa, Okla. '25
‖Acosta-Sarmiento, Gonzalo, Edificio Colombia, Of. 602–603, Carrera 9, No. 14–36, Bogota, Colombia, S. A. '42
‖Adair, J. Smith, U. S. Forest Service, Ogden, Utah '45
Adams, Bradford Clarendon, The Texas Co., 929 S. Broadway, Los Angeles, Calif. '41
Adams, Clyde B., Socony-Vacuum Oil Co., Inc., Rm. 1700, 26 Broadway, New York, N. Y. '41
Adams, Elmo W., Honolulu Oil Corp., 215 Market St., San Francisco, Calif. '30
Adams, Frank C., consulting, Rt. 8, Tyler, Tex. '27
Adams, John Emery, Standard Oil Co. of Texas, Box 1249, Houston, Tex. '29
Adams, Kilburn Elie, Jr., The Texas Co., Box 1801, Wichita, Kan. '38
Adams, Robert James, Phillips Petr. Co., 3102 Milby, Wichita Falls, Tex. '42
‖Adams, Robert Wiley, Box 664, Reseda, Calif. '42
Adams, W. C., independent, 1224 Hazel Blvd., Tulsa, Okla. '24
‖Addington, Harold Wallace, The California Co., Rangely, Colo. '43
Addington, James William, Humble Oil & Refg. Co., 202 Humble Bldg., Houston, Tex. '44
Addison, Carl C., Pure Oil Co., 747 Canal Bldg., New Orleans, La. '30

Aderman, Charles Vidor, Keystone Explor. Co., 2813 Westheimer Rd., Houston, Tex. '45
Adkins, W. S., Shell Oil Co., Inc., Box 2099, Houston, Tex. '20
‖Adkisson, Albert W., independent, 2019 W. T. Waggoner Bldg., Fort Worth, Tex. '34
‖Adler, Frank J., Stanolind Oil & Gas Co., 619 N. Eleventh St., Garden City, Kan. '45
Adler, Joseph L., Independent Prospecting Co., 901 Esperson Bldg., Houston, Tex. '30
Agee, Flint Humphrey, United Geophysical Co., Huntington Park, Calif. '38
Agey, Charles Samuel, Amerada Petr. Corp., 613 Orpheum Bldg., Wichita, Kan. '38
Agnew, Allen Francis, Stanford Univ., Stanford University, Calif. '44
Agnich, Fred J., Geophysical Service, Inc., 1311 Republic Bank Bldg., Dallas, Tex. '41
Aguerrevere, Pedro I., c/o Venezuelan Embassy, 2445 Massachusetts Ave., Washington, D. C. '24
Aguerrevere, Santiago E., Estados Unidos de Venezuela, Apt. 1253, Caracas, Venezuela, S. A. '24
Aimer, James D., Barndall Oil Co., 427 Ricou-Brewster Bldg., Shreveport, La. '26
Ainsworth, David, Western Petr. Explor. Co., Wichita, Kan. '23
Aitken, William Ernest, Richmond Petr. Co. of Colombia, Apt. Postal 2760, Bogota, Colombia, S. A. '32
‖Akers, Wilburn Holt, Univ. of Oklahoma, Norman, Okla. '41
Akkerman, Richard Pete, General Geophysical Co., Houston, Tex. '41
Alagood, Robert Henson, Sunray Oil Corp., 613 Tower Bldg., Jackson, Miss. '39
Alba y Soto, Alonso de, Petroleos Mexicanos, Apt. 150, Tampico, Tamps., Mex. '45
Alberding, Herbert, Texas Petr. Co., Bogota, Colombia, S. A. '40
Albert, Emil Richard, Jr., Mud Products, Inc., 508 Philtower Bldg., Tulsa, Okla. '42
Albertson, Maurice M., Box 1154, Houston, Tex. '20
‖Albright, Charles C., Jr., Long Beach Oil Devel. Co., 255 S. Santa Clara, Long Beach, Calif. '45
Albright, Emory Glenn, The Atlantic Refg. Co., St. Petersburg, Fla. '47
Albritton, Claude Carroll, Jr., U. S. Geol. Survey, Dallas, Tex. '39
Alcorn, Avary Hunt, The Atlantic Refg. Co., 1742 Milam Bldg., San Antonio, Tex. '32
‖Alcorn, James Munrex, Hal Roach Studios, Inc., Culver City, Calif. '42
Aldrich, Henry R., Geological Society of America, 419 W. One Hundred Seventeenth St., New York, N. Y. '45
Alexander, C. I., Magnolia Petr. Co., Box 780, Tyler, Tex. '27
Alexander, Clyde Wayne, Dixie Geol. Service, 202 Tower Bldg., Jackson, Miss. '38
‖Alexander, Joseph Watrous, Cities Service Oil Co., Box 4577, Capitol Hill Sta., Oklahoma City, Okla. '43
‖Alexander, Walter Herbert, Jr., U. S. Geol. Survey, Livingston, Tex. '42
Alkire, Robert Leo, West Virginia Univ., Morgantown, W. Va. '47
Allan, John Andrew, Univ. of Alberta, Edmonton, Alta., Canada '30
Allan, Thomas H., consulting, 921 Union Natl. Bank Bldg., Wichita, Kan. '24
‖Allardyce, Robert Edward Lee, Jr., Stanolind Oil & Gas Co., Box 659, Casper, Wyo. '42
Allen, Alton C., Rowan & Nichols Oil Co., 903 Commercial Standard Bldg., Fort Worth, Tex. '35
Allen, Bryant W., Woodley Petr. Co., 211 Deposit Guaranty Bank Bldg., Jackson, Miss. '25
‖Allen, Charles Francis, Western Geophysical Co., Greenriver, Utah '42
Allen, Charles Maurice, Phillips Petr. Co., 521 Esperson Bldg., Houston, Tex. '46
Allen, Devere F., 1453 Safford Ave., Fresno, Calif. '29
Allen, Donald M., Westgate-Greenland Oil Co., 1022 Union Natl. Bank Bldg., Wichita, Kan. '24
Allen, E. G., independent, 6745 Avalon Ave., Dallas, Tex. '17
Allen, Frank Tilbury, Gulf Research & Devel. Co., Box 2038, Pittsburgh, Pa. '39
Allen, Harris Hayes, Phillips Petr. Co., 521 Esperson Bldg., Houston, Tex. '39
Allen, John Eliot, Oregon Dept. of Geol. & Mineral Industries, Woodlark Bldg., Portland, Ore. '46
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Allen, William Hammond, Shell Oil Co., Inc., Box 1509, Midland, Tex. '40
‖Allen, William Odis, Jr., Bay Petr. Corp., 1006 Brown Bldg., Wichita, Kan. '39
Allin, Philip Robert, Gulf Refg. Co., Box 37, Harvey, La. '47
Allison, A. P., Sun Oil Co., Box 2645, Houston, Tex. '21
Allon, Meyer Michael, Gulf Research & Devel. Co., Box 2038, Pittsburgh, Pa. '37
Alpha, Andrew G., General Petr. Corp., Great Falls, Mont. '43
‖Alquist, Francis Nelson, 2416 Manon Dr., Midland, Mich. '38
‖Alvarado, Benjamin, Ministerio de Minas y Petroleo, Bogota, Colombia, S. A. '38
Alvarez, Manuel, Jr., Petroleos Mexicanos, Nogal 52, Mexico, D. F., Mex. '36
Ambrose, A. W., Cities Service Oil Co., Box 395, Bartlesville, Okla. '19
Ames, Edward W., Strategic Metals Div., U. S. Bureau of Mines, Denver, Colo. '19
‖Ammon, Walter Lamm, Stanolind Oil & Gas Co., Wichita Falls, Tex. '46
Amstutz, Platte T., Jr., Sohio Petr. Co., 2309 First Natl. Bldg., Oklahoma City, Okla. '44
‖Amyx, James William, Pennsylvania State College, Box 116, State College, Pa. '46
‖Andersen, Harold V., Louisiana State Univ., Baton Rouge, La. '40

Anderson, Benjamin Louis, Skelly Oil Co., Box 1822, Pampa, Tex. '45
Anderson, Carl B., Gulf Refg. Co., Box 482, Mattoon, Ill. '19
Anderson, Carl C., U. S. Bureau of Mines, Washington, D. C. '32
Anderson, Carl T., Republic Natural Gas Co., 1155 First Natl. Bldg., Oklahoma City, Okla. '41
Anderson, Carlos O., Myles Salt Co., Weeks, La. '46
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‖Anderson, Kenneth Clyde, Standard Oil Co. of Texas, Midland, Tex. '42
‖Anderson, Oscar Samuel, Jr., Big Four Petr. Co., Box A, Oilton, Okla. '39
‖Anderson, Payton Victor, Humble Oil & Refg. Co., Canal Bldg., New Orleans, La. '46
Anderson, Ray Ball, Columbian Carbon Co., Box 873, Charleston, W. Va. '24
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Anderson, Richard S., Anderson, Huffman & Johnson, Box 1884, Midland, Tex. '31
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Anderson, Robert van Vleck, Stanford Univ., Stanford University, Calif. '23
Anderson, Rudolph Faraday, consulting, 2504 Pine Ave., Mattoon, Ill. '42
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Anderson, Warren D., Anderson, Huffman & Johnson, Box 1884, Midland, Tex. '27
Andrau, Evert Willem Karel, consulting, Box 2408, Houston, Tex. '32
Andrews, David Arthur, U. S. Geol. Survey, N. Interior Bldg., Washington, D. C. '44
Andrews, Harry Hugh, Seismograph Service Corp., 709 Kennedy Bldg., Tulsa, Okla. '30
Andrews, Philip, Box 266, Boulder, Colo. '25
Andrews, Thomas Gayleon, Univ. of Alabama, University, Ala. '37
Andrews, Wilton W., Humble Oil & Refg. Co., 863 Humble Bldg., Houston, Tex. '36
‖Anisgard, Harry William, Creole Petr. Corp., Apt. 889, Caracas, Venezuela, S. A. '41
Apfel, Earl T., Syracuse Univ., Syracuse, N. Y. '29
‖Applegate, Margaret Jayne, Sun Oil Co., Home Bank Bldg., Toledo, Ohio '47
Applin, Paul L., U. S. Geol. Survey, Tallahassee, Fla. '19
Archie, Gustave Erdman, Shell Oil Co., Inc., Box 2099, Houston, Tex. '38
Argabrite, William Graeme, consulting, Box 33, Lewisburg, W. Va. '28
Arellano, A. R. V., consulting, Apt. 7527, Mexico, D. F., Mex. '38
Arick, Millard B., independent, Box 87, Midland, Tex. '27
Arleth, Karl, Standard Oil Co. of Calif., San Marino, Calif. '39
Armstrong, Earle N., Tennessee Gas & Transmission Co., Box 2511, Houston, Tex. '33
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‖Brooks, Tennant Julian, c/o Glenn C. Ferguson, Professional Bldg., Bakersfield, Calif.....'44
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Broussard, E. Chester, Harrison Oil Co., 2105 Gulf Bldg., Houston, Tex.....'46
‖Broussard, Lloyd J., consulting, 2402 Esperson Bldg., Houston, Tex.....'38
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Browning, John Mackintosh, Tropical Oil Co., Bogota, Colombia, S. A.....'46
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‖Burchard, Frederic L., DeGolyer & MacNaughton, 1000 Continental Bldg., Dallas, Tex.....'39
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Ellsworth, Theodore Phelps, Richfield Oil Corp., 560 Haberfelde Bldg., Bakersfield, Calif.....'43
Elms, Morris Allen, Phillips Drilling Co., 306 Milam Bldg., San Antonio, Tex.....'38
Elson, William H., independent, 331 Beacon Bldg., Tulsa, Okla.....'27
Ely, George Norman, Continental Oil Co., 907 Peoples Natl. Bank Bldg., Tyler, Tex.....'40
Emch, John W., independent, San Angelo Natl. Bank Bldg., San Angelo, Tex.....'25
Emery, Kenneth Orris, Univ. of Southern California, Los Angeles, Calif.....'43
Emery, Wilson B., The Ohio Oil Co., Findlay, Ohio.....'23
Emmerich, Harry H., Magnolia Petr. Co., Box 3671, West Jackson, Miss.....'39
*Emmons, William H., Univ. of Minnesota, Minneapolis, Minn.....'19
Emrick, D. G., Gulf Oil Corp., Box 661, Tulsa, Okla.....'28
Enders, Dean W., Tide Water Assoc. Oil Co., Box 1708, Casper, Wyo.....'41

Erhard, Milo George, Honolulu Oil Corp., Bakersfield, Calif. '47
Engel, Noel W., The Superior Oil Co., Citizens Natl. Bank Bldg., Evansville, Ind. '38
Engelman, Rolf, Carter Oil Co., 1300 Apco Tower, Oklahoma City, Okla. '25
English, Leon E., 1311 W. Santa Barbara, Los Angeles, Calif. '18
English, Robert M., Carter Oil Co., Box 568, Mattoon, Ill. '36
English, Walter A., Continental Air Map Co., 114 S. Beaudry Ave., Los Angeles, Calif. '19
Engstrand, Clinton, Kansas Sample Log Service, 415 N. Pershing, Wichita, Kan. '35
‖Erdman, Oscar Alvin, Gulf Research & Devel. Co., 507 Lancaster Bldg., Calgary, Alta., Canada '44
Erdmann, Charles E., U. S. Geol. Survey, Box, 1827, Great Falls, Mont. '30
Erhard, Milo George, Honolulu Oil Corp., Bakersfield, Calif. '47
Erickson, Arthur R., Phillips Petr. Co., Amarillo, Tex. '46
Erickson, Earling Lester, Continental Oil Co., 700 Edison Bldg., Los Angeles, Calif. '45
‖Ericson, Harry Berkeley, Cities Service Oil Co., Bartlesville, Okla. '46
‖Ervin, Lynn Delbert, Stanolind Oil & Gas Co., Glenwood Springs, Colo. '40
Esarey, Ralph E., Indiana Univ., Bloomington, Ind. '32
Escallon, Marion Roberta de, Taca de Colombia, Apt. Nacl. 2727, Bogota, Colombia, S. A. '40
Esgen, W. K., c/o William B. Baldy, 1706 Esperson Bldg., Houston, Tex. '29
Eskrigge, Tatham R., Gulf Refg. Co., Box 37, Harvey, La. '30
Espach, Ralph Homeward, U. S. Bureau of Mines, Box 621, Laramie, Wyo. '37
Estabrook, Edward L., Standard Oil Co. (N. J.), Rm. 2763, 30 Rockefeller Plaza, New York, N. Y. '20
‖Esterak, Leroy, Republic Natural Gas Co., Hugoton, Kan. '46
Estergren, Edmund Frederick, 3203 Wellborn St., Dallas, Tex. '29
‖Esunas, Bernard Joseph, Byrd-Frost, Inc., 1110 Tower Petr. Bldg., Dallas, Tex. '40
Etherington, Thomas J., Standard Oil Co. of Calif., 225 Bush St., San Francisco, Calif. '33
‖Evans, David LeCount, The Ohio Oil Co., 710 Brown Bldg., Wichita, Kan. '46
Evans, David Morgan, The Sharples Corp., Box 180, Denver, Colo. '37
Evans, Frank Garrettson, Shell Oil Co., Inc., Box 2099, Houston, Tex. '28
‖Evans, Louis H., California State Board of Equalization, Los Angeles, Calif. '24
Evans, Noel, Adkins Oil Co., Philtower Bldg., Tulsa, Okla. '20
Evans, Ralph, Standard Oil Co. of Texas, 1604 Milam Bldg., San Antonio, Tex. '45
‖Evans, Robert Pierce, Lion Oil Co., El Dorado, Ark. '43
Evans, Vincent, Skelly Oil Co., Box 451, La Junta, Colo. '31
Everett, Rizer, Carter Oil Co., 1300 Apco Tower, Oklahoma City, Okla. '38
‖Everett, Robert Walter, Jr., The Texas Co., Box 252, New Orleans, La. '43
‖Ewbank, Norman Ware, Jr., Ewbank Equipment Co., Independence, La. '43
‖Ewing, Rudolph V., Continental Oil Co., Box 2511, West Jackson, Miss. '41
‖Eyoub, Leila Lisette, Gulf Oil Corp., Box 110, Amarillo, Tex. '46
Eyssell, Alfred Raah, 2151 Mulberry, San Antonio, Tex. '25

‖Fackler, John Henry, Chanslor-Canfield Midway Oil Co., 4549 Produce Plaza, W., Los Angeles, Calif. '39
Fagginger-Auer, Willem A., Gulf Oil Corp., 17 Battery Pl., New York, N. Y. '41
Fahle, Paul Bartlett, Plymouth Oil Co., Box 727, El Dorado, Ark. '38
‖Failing, William Earl, Humble Oil & Refg. Co., Paradis, La. '46
‖Falconer, Wilbert Lawrence, 611 Twelfth Ave., E., Calgary, Alta., Canada '41
‖Falletti, Antonio D., independent, 116 S. Alvord Blvd., Evansville, Ind. '38
Fanshawe, John Richardson, General Petr. Corp., Box 1652, Casper, Wyo. '40
Farlee, Richard Wilson, Shell Oil Co., Inc., Box 1109, Tallahassee, Fla. '41
Farley, William Richard, Explor. Dept., Union Sulphur Co., Sulphur, La. '39
‖Farmer, Paul, Gulf Refg. Co., Box 482, Mattoon, Ill. '42
Farmer, Russell, Stanolind Oil & Gas Co., Box 1410, Fort Worth, Tex. '40
‖Farmilo, Alfred William, The Calif. Standard Co., 700 Lancaster Bldg., Calgary, Alta., Canada '43
‖Farrand, William Gardner, Sun Oil Co., Old Natl. Bank Bldg., Evansville, Ind. '40
Farrell, Agnes M., U. S. Geol. Survey, Washington, D. C. '26
Farrow, Benjamin Darwin, The Geotechnical Corp., 1702 Tower Petr. Bldg., Dallas, Tex. '44
Fash, Ralph H., consulting, Box 1379, Fort Worth, Tex. '27
Fath, A. E., Socony-Vacuum Oil Co., Inc., Rm. 1700, 26 Broadway, New York, N. Y. '17
‖Faust, Josef, consulting, 618 Commerce Exchange Bldg., Oklahoma City, Okla. '31
Feagin, Barney, Jr., independent, 330 Ritz Bldg., Tulsa, Okla. '30
Feather, Virgil G., Honolulu Oil Corp., Box 1557, Lubbock, Tex. '38
‖Fee, Samuel Thomas, Shell Oil Co., Inc., Box 515, Chickasha, Okla. '44
‖Feister, George Harold, 408-B W. Lemon St., Santa Maria, Calif. '47
Feldmeyer, Arthur E., The Superior Oil Co., 930 Edison Bldg., Fifth & Grand Ave., Los Angeles, Calif. '39

Feldmiller, Charles Henry, Equitable Gas Co., Pittsburgh, Pa.....'45
‖Fell, Harold B., Simpson-Fell Oil Co., Box 778, Ardmore, Okla.....'36
Fellows, Robert Arthur, Pure Oil Co., Box 1398, Billings, Mont.....'41
Felts, Wayne Moore, Phillips Petr. Co., 220 Research Bldg., Bartlesville, Okla.....'45
‖Fender, Hollis Blair, Dept. of Soil Investigation, Wabash River Ordnance Works, Bloomington Ind.....'42
‖Fenichell, Melvin Medford, Industrial Relations, Creole Petr. Corp., Apt. 889, Caracas, Venezuela, S. A.....'44
Fenn, Ivan J., Salt Dome Oil Corp., 1900 Mellie Esperson Bldg., Houston, Tex.....'29
Fenwick, Willis Henry, Brown Geophysical Co., Box 319, Casper, Wyo.....'44
‖Feray, Dan Edwards, Univ. of Wisconsin, Madison, Wis.....'40
Ferber, Herbert James, Gulf Research & Devel. Co., Box 375, La Junta, Colo.....'39
‖Ferebee, D. M., The California Co., 1818 Canal Bldg., New Orleans, La.....'39
Fergus, Preston, Union Prod. Co., Box 1422, Monroe, La.....'27
Ferguson, Carlos Mose, Magnolia Petr. Co., Box 1988, Amarillo, Tex.....'39
‖Ferguson, Fred Travis, The Ohio Oil Co., Box 1168, Tampa, Fla.....'44
Ferguson, Glenn C., consulting, Rm. 1, Professional Bldg., 1829 H St., Bakersfield, Calif.....'30
‖Ferguson, Herman W., Tennessee Div. of Geol., G-5 State Office Bldg., Nashville, Tenn.....'41
Ferguson, Hershal Cevera, consulting, 1208 Esperson Bldg., Houston, Tex.....'38
Ferguson, Jack B., Apache Explor. Co., Box 1711, Houston, Tex.....'43
‖Ferguson, John Inger, J. B. Ferguson Co., 314 Security Bldg., Sioux City, Iowa.....'41
Ferguson, John L., Amerada Petr. Corp., Box 2040, Tulsa, Okla.....'20
Ferguson, Kenneth Howell, consulting, Niels Esperson Bldg., Houston, Tex.....'36
Ferguson, Marion Lee, Republic Natural Gas Co., 1505 Federal St., Dallas, Tex.....'39
Ferguson, R. N., consulting, 1332 A. G. Bartlett Bldg., Los Angeles, Calif.....'19
Ferguson, Robert Dewitt, U. S. Geol. Survey, Casper, Wyo.....'46
Ferguson, William Boyd, Fluorographic Explor. Co., 1517 Second Natl. Bank Bldg., Houston, Tex.....'29
Ferrando, Aldo, independent, 942 Milam Bldg., San Antonio, Tex.....'38
Ferrell, Jane, Magnolia Petr. Co., Box 633, Midland, Tex.....'41
‖Ferrell, Max Everett, Carter Oil Co., Box 1268, Durango, Colo.....'41
Ferrero, Clarence F., 607 W. Hullum, Breckenridge, Tex.....'28
Ferris, Craig, E. V. McCollum & Co., Thompson Bldg., Tulsa, Okla.....'45
Feruglio, Egidio S., Inst. del Petroleo, Universidad Nacional, B. Mitre 660, Mendoza, Argentina, S. A.....'38
‖Feth, John Henry, 3202 E. Twenty-seventh St., Tucson, Ariz.....'45
Fettke, Charles R., Carnegie Inst. of Tech., Pittsburgh, Pa.....'20
Fichter, Hans Jakob K., The Caribbean Petr. Co., Apt. 809, Caracas, Venezuela, S. A.....'41
Fidlar, Marion Moore, Mountain Fuel Supply Co., Rock Springs, Wyo.....'39
Fields, Harry B., Carter Oil Co., Box 321, Vernal, Utah.....'28
‖Fienning, Robert Louis, Pure Oil Co., Box 271, Tulsa, Okla.....'44
Fillman, Louise, Shell Oil Co., Inc., Box 1509, Midland, Tex.....'44
Fillmore, Ralph L., independent, 3204 Apco Tower, Oklahoma City, Okla.....'43
Finch, Elmer H., Apt. 22, The Avondale, 1734 P St., N. W., Washington, D. C.....'22
‖Finch, Kenneth Day, Schlumberger Well Surveying Corp., Box 92, Shreveport, La.....'45
Findlay, Willard Alexander, Standard Oil Co. of Calif., 225 Bush St., San Francisco, Calif.....'42
‖Finfrock, Lawrence Johnson, Carter Oil Co., Box 801, Tulsa, Okla.....'41
‖Finley, Emmett Atkins, Creole Petr. Corp., Apt. 172, Maracaibo, Venezuela, S. A.....'46
Finley, Jean Carson, Midstates Oil Co., 518 Natl. Bank of Tulsa Bldg., Tulsa, Okla.....'34
Finn, Fenton Harrison, Peoples Natural Gas Co., 545 William Penn Way, Pittsburgh, Pa.....'41
Fipps, E. L., Plymouth Oil Co., Sinton, Tex.....'26
Firstenberger, John Graeme, Phillips Petr. Co., Box 791, Midland, Tex.....'46
Fischer, Alfred George, 1025 John Hay Hall, Columbia Univ., New York, N. Y.....'45
Fischer, LeRoy Fred, Sohio Petr. Co., Box 1667, Shreveport, La.....'42
Fischer, Victor Nathaniel, 614 Ockley Dr., Shreveport, La.....'38
Fish, Leroy, consulting, 2517 Transit Tower, San Antonio, Tex.....'41
‖Fisher, Arnold J., independent, 6237 Kester Ave., Van Nuys, Calif.....'45
Fisher, Barney, Coronado Corp., 406 Continental Bldg., Dallas, Tex.....'36
Fisher, Dunbar Allen, Humble Oil & Refg. Co., Box 2180, Houston, Tex.....'36
‖Fisher, Frank Lynn, Jr., Ashland Oil & Refg. Co., 514 Citizens Natl. Bank Bldg., Ashland, Ky.....'38
Fisher, Gordon Henderson, Gulf Oil Corp., Box 1290, Fort Worth, Tex.....'42
Fisk, Frank Karr, Explor. Surveys, Inc., 1914 N. Harwood St., Dallas, Tex.....'46
Fisk, Harold N., Louisiana State Univ., Baton Rouge, La.....'38
Fitting, Ralph U., Jr., consulting, Box 1299, Midland, Tex.....'42

‖Fitts, L. E., Jr., Sinclair Prairie Oil Co., Box 521, Tulsa, Okla.....'42
FitzGerald, James, Jr., independent, Box 1565, Midland, Tex.....'25
FitzGerald, Norman D., independent, Box 1772, Abilene, Tex.....'44
Fitzgerald, Paul E., Dowell, Inc., 524 Kennedy Bldg., Tulsa, Okla.....'30
Fitzgerald, Thomas J., Richfield Oil Corp., 560 Haberfelde Bldg., Bakersfield, Calif.....'29
Flagler, C. W., Danish-American Prospecting Co., Gammeltorv, 6, Copenhagen, Denmark.....'30
Flesh, David James, Jefferson Oil & Gasoline Co., Jefferson, Tex.....'38
Fletcher, Claude Osborne, Union Prod. Co., Box 711, Beeville, Tex.....'36
‖Fletcher, Roy William, Jr., The Texas Co., Bakersfield, Calif.....'46
Flowers, Jackson Jefferson, 2415 Calumet St., Houston, Tex.....'38
Floyd, Florin W., Standard Oil Co. of Venezuela, Apt. 1249, Caracas, Venezuela, S. A.....'23
‖Floyd-Jones, Jane, Magnolia Petr. Co., Tyler, Tex.....'45
Flude, John William, independent, 3039 Locke Lane, Houston, Tex.....'37
Fly, Paul J., consulting, Box 471, Victoria, Tex.....'31
Fohs, F. Julius, Fohs Oil Co., 248 Mellie Esperson Bldg., Houston, Tex.....'17
Foley, Edward J., 409 S. Grand, Bozeman, Mont.....'38
Folger, Anthony, c/o Nebraska Geol. Survey, Lincoln, Nebr.....'22
Folk, Stewart H., U. S. Geol. Survey, c/o O-in-CC, NOy 13360, Box 1310, Fairbanks, Alaska.....'40
Folsom, Lucas Wendell, The California Co., Box 890, Lexington, Ky.....'40
Folsom, Tom Erwin, I. B. Stabba & Cia., Ltds., Caixa Postal 39, Manaus, Brazil, S. A.....'43
Fonville, Herman Albert, Colombian Gulf Oil Co., Apt. 4014, Bogota, Colombia, S. A.....'27
Foraker, William S., 459 High Dr., Laguna Beach, Calif.....'26
Foran, William Thomas, 3329 Yonge St., San Diego, Calif.....'31
Forcade, Kirk Charles, consulting, 628 First Natl. Bank Bldg., Denver, Colo.....'43
Ford, Carl S., consulting, Box 1228, Enid, Okla.....'18
Ford, Robert Davis, Schlumberger Well Surveying Corp., Long Beach, Calif.....'45
Ford, Waldo Emerson, Jr., Royalty Service Corp., Ltd., 555 S. Flower St., Los Angeles, Calif.....'38
Forgeron, Harold S., consulting, Box 1575, Midland, Tex.....'28
Forgotson, James M., consulting, 611 City Bank Bldg., Shreveport, La.....'29
Forney, Maurice Edgar, The Atlantic Refg. Co., 1742 Milam Bldg., San Antonio, Tex.....'41
Forrest, Lesh C., Chanslor-Canfield Midway Oil Co., Professional Bldg., Bakersfield, Calif.....'38
Forrester, James Donald, Missouri School of Mines, Rolla, Mo.....'47
Forsyth, Roderick James, Case, Pomeroy & Co., Inc., Tulsa, Okla.....'38
Fort, Ellsworth William, Shell Oil Co., Inc., 1806 South St., Lake Charles, La.....'46
Fortier, Leo R., Alpine Oil & Royalty Co., Inc., Wichita, Kan.....'25
Fortine, Dwight H., Barnsdall Oil Co., Petr. Bldg., Los Angeles, Calif.....'30
Forward, Frederick William, Phillips Petr. Co., Lamesa, Tex.....'43
Fosdick, Arthur R., Fosdick & Mouser, Hamilton Bldg., Wichita Falls, Tex.....'32
Fossa-Mancini, Enrico, Museo de La Plata, La Plata, Argentina, S. A.....'31
Fosshage, Ernest Willard, Shamrock Oil & Gas Co., Amarillo Bldg., Amarillo, Tex.....'37
‖Foster, Abner Lipscomb, Luling Oil & Gas Co., Houston, Tex.....'46
Foster, Alden W., consulting, 1711 Oliver Bldg., Pittsburgh, Pa.....'20
Foster, Fred K., 711 Alamo Natl. Bldg., San Antonio, Tex.....'21
Foster, Paul Woodward, Williams College, Williamstown, Mass.....'42
‖Fothergill, Harold Lawrence, Union Oil Co. of Calif., Los Angeles, Calif.....'46
‖Fountain, Henry Coleman, independent, Anson, Tex.....'40
Fournier, Frank Lawrence, Imperial Oil Ltd., 56 Church St., Toronto, Ont., Canada.....'41
‖Fouts, John M., Jr., Shell Oil Co., Inc., Box 32, Kilgore, Tex.....'38
Fowler, Charles W., Jr., United Oilwell Service, S. A., Apt. 1085, Caracas, Venezuela, S. A.....'26
Fowler, George M., consulting, 608 Joplin Natl. Bank Bldg., Joplin, Mo.....'23
‖Fowler, Henry Florey, Gulf Refg. Co., Box 1731, Shreveport, La.....'42
‖Fowler, Virginia Tolbert, 1133 S. Jenkins, Norman, Okla.....'45
Fowler, William James, Panhandle Refg. Co., Box 1191, Wichita Falls, Tex.....'42
Fox, Frederick Glenn, Irving House, Box 7, Woodrow Wilson Center, Norman, Okla.....'43
‖Fox, Hamlin Garland, Tide Water Seaboard Oil Co., Tyler, Tex.....'44
Fox, James P., Standard Oil Co. of Texas, Box 1249, Houston, Tex.....'29
Fox, Steven Knowlton, Princeton Univ., Princeton, N. J.....'40
Fralich, Charles Eugene, Appalachian Devel. Corp., Box 252, Bradford, Pa.....'25
Franklin, Donald Wilbert, The Ohio Oil Co., 902 Hamilton Bldg., Wichita Falls, Tex.....'42
Franklin, Louis, independent, Mellie Esperson Bldg., Houston, Tex.....'20
‖Frank, Anne Moring Robins, General Geophysical Co., Houston, Tex.....'42
Franks, Robert M., consulting, Box 970, Alice, Tex.....'30
Franques, Howard Luckett, The Superior Oil Co., Box 1066, Lafayette, La.....'46
Franz, Leslie James, Gulf Oil Corp., Box 2100, Houston, Tex.....'46

Frazell, William Davis, Union Prod. Co., Box 1407, Shreveport, La.....'38
Frazier, Gaylord G., U. S. Geol. Survey, 416 Denham Bldg., Denver, Colo.....'28
‖Frederickson, Edward Arthur, Univ. of Oklahoma, Norman, Okla.....'41
Freed, Richard, The Texas Co., Box 1737, Shreveport, La.....'40
Freedman, Louis H., Snowden & Freedman, Fort Worth, Tex.....'22
Freeman, Louise Barton, consulting, 608 Elsmere Park, Lexington, Ky.....'41
Freie, A. J., Creole Petr. Corp., Apt. 889, Caracas, Venezuela, S. A.....'28
‖French, Harvey F., 1295 S. Ogden St., Denver, Colo.....'45
‖Frenzel, Hugh N., Standard Oil Co. of Texas, Carlsbad, N. Mex.....'46
Frericks, Alvin Louis, Skelly Oil Co., Box 2386, Corpus Christi, Tex.....'46
Frey, Alfred P., Shell Oil Co., Inc., Centralia, Ill.....'24
Frey, Maurice Gordon, The California Co., 1006 U. S. Natl. Bank Bldg., Denver, Colo.....'45
‖Fricke, Kenneth Stewart, Texas Petr. Co., Apt. 267, Caracas, Venezuela, S. A.....'45
Fritts, Harold M., Shell Oil Co., Inc., Explor. Dept., Box 2099, Houston, Tex.....'20
Fritz, Edward Blake, Union Oil Co. of Calif., Box 511, Compton, Calif.....'46
Fritz, William Clayton, independent, 1910 W. College St., Midland, Tex.....'35
Frizzell, Donald Leslie, Univ. of Texas, Austin, Tex.....'40
Frizzell, Mildred V. Armor, independent, 3321 N. Virginia St., Oklahoma City, Okla.....'30
‖Frossard, Robert L., Seismograph Service Corp., 709 Kennedy Bldg., Tulsa, Okla.....'45
Frost, Jack, Byrd-Frost, Inc., 1110 Tower Petr. Bldg., Dallas, Tex.....'22
Frost, Jay Miles, III, independent, 803 Mellie Esperson Bldg., Houston, Tex.....'38
Frost, Victor LeRoy, The Ohio Oil Co., Thompson Bldg., Tulsa, Okla.....'45
Fruehling, Siegfried William, Seismograph Service Corp., 709 Kennedy Bldg., Tulsa, Okla.....'45
‖Fry, Earl E., Pan-American Prod. Co., 12th Fl., Mellie Esperson Bldg., Houston, Tex.....'40
Frye, John Chapman, State Geol. Survey, Univ. of Kansas, Lawrence, Kan.....'44
‖Fryou, Joe A., Humble Oil & Refg. Co., Box 1271, Corpus Christi, Tex.....'40
‖Fu, Ch'eng Yi, Calif. Inst. of Tech., Pasadena, Calif.....'43
‖Fulghum, Henry Leroy, Pure Oil Co., Box 239, Houston, Tex.....'40
Fulk, Frank Floyd, Box 1126, Fort Stockton, Tex.....'43
Fuller, Melville Weston, Carter Oil Co., Box 801, Tulsa, Okla.....'36
Fuller, Oscar Kenneth, Jr., 2655 Las Lumas St., Pasadena, Calif.....'47
‖Fulmer, Edward Andrew Martin, California Standard Co., Princess, Alta., Canada.....'46
Fulton, Loris J., Pure Oil Co., Box 1398, Billings, Mont.....'29
Funk, Fred J., The Ohio Oil Co., Findlay, Ohio.....'28
Funkhouser, E. M., Woodley Petr. Co., Box 1872, Abilene, Tex.....'36
‖Funkhouser, Harold John, Mene Grande Oil Co., Apt. 709, Caracas, Venezuela, S. A.....'39
Fuqua, H. B., Gulf Oil Corp., Box 2100, Houston, Tex.....'20
‖Fuqua, Marjorie Charline, 505 Bolivar St., Bellaire, Tex.....'40
Futral, John Edward, The Texas Co., Box 2332, Houston, Tex.....'44
Fyfe, Douglas, Ministerio de Fomento, Arenales 1423, Lima, Peru, S. A.....'20

‖Gabelman, John W., Apt. 9, 1071 Marion St., Denver, Colo.....'43
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Gaby, Phillip Pritchett, Standard Oil Co. of Calif., 1129 Standard Oil Bldg., San Francisco, Calif.....'43
Gaddess, Gene, Pure Oil Co., Olney, Ill.....'43
Gaddess, Jack, North Pennsylvania Gas Co., Port Allegany, Pa.....'25
Gaenselen, George, Standard Oil Co. of Egypt, Bag 1, Cairo, Egypt.....'38
Gaffney, John Edward, Lion Oil Co., Box 1298, El Dorado, Ark.....'41
‖Gagnebin, Elie A., Laboratoire de Geologie, Universite, Lausanne, Switzerland.....'40
Gahagan, Donald L., Skelly Oil Co., 1353 Esperson Bldg., Houston, Tex.....'39
Gahring, William Ross, Ross Oil Co., Box 520, Shawnee, Okla.....'25
‖Gaige, Gerald Robert, Magnolia Petr. Co., Box 535, Mt. Vernon, Ill.....'46
Galbraith, Thomas J., Standard Oil Co. of Calif., Rm. 1130, 225 Bush St., San Francisco, Calif.....'20
Galbreath, Glenn, independent, 1303 Main, Mt. Vernon, Ill.....'40
Gale, Arthur Sullivan, Jr., Pan-American Prod. Co., 1247 Mellie Esperson Bldg., Houston, Tex.....'39
Gale, Hoyt Rodney, Univ. of Southern California, Los Angeles, Calif.....'29
‖Galeski, Robert Benjamin, United Geophysical Co., Pasadena, Calif.....'42
Galey, John Taylor, independent, Box 1675, Pittsburgh, Pa.....'35
Gallagher, John Patrick, Standard Oil Co. (Peru), Box 1081, Lima, Peru, S. A.....'43
Galley, John E., Shell Oil Co., Inc., Box 1191, Tulsa, Okla.....'29
Gallie, John Francis, Cabot Carbon Co., Box 1101, Pampa, Tex.....'41
Galloway, Alan James, Shell Oil Co., Inc., Box 2099, Houston, Tex.....'39
Galloway, George Harold, Stanolind Oil & Gas Co., Box 1633, Oklahoma City, Okla.....'41
Galloway, Jesse J., Univ. of Indiana, Bloomington, Ind.....'25

Galloway, John O., The Calif. Standard Co., 700 Lancaster Bldg., Calgary, Alta., Canada....'21
Gallup, W. B., Imperial Oil Co., Turner Valley, Alta., Canada....'43
Galpin, Sidney L., Agr. Exp. Sta., West Virginia Univ., Morgantown, W. Va....'19
Galpin, Sidney Stewart, Peoples Natural Gas Co., 545 William Penn Way, Pittsburgh, Pa....'42
‖Gandy, Thomas Stephens, The Atlantic Refg. Co., 1742 Milam Bldg., San Antonio, Tex....'44
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Gardiner, Chester M., consulting, 110 Emporium Bldg., 133 E. Philadelphia St., Whittier, Calif..'25
‖Gardner, A. Maclay, Lane-Wells Co., Hollywood, Calif....'30
Gardner, Dion Lowell, Orange County Water Dist., 222 Santa Ana Community Center, Santa Ana, Calif....'46
Gardner, Edgar Jackson, Gulf Oil Corp., Box 1290, Fort Worth, Tex....'39
Gardner, Frank Johnson, Rinehart Oil News Co., Box 1702, Houston, Tex....'40
‖Gardner, Jack Winston, Gulf Oil Corp., 1107 Union Natl. Bank Bldg., Wichita, Kan....'38
Gardner, James H., Gardner Petr. Co., 326 Beacon Bldg., Tulsa, Okla....'17
Gardner, Julia, U. S. Geol. Survey, Washington, D. C....'27
Gardner, Louis S., U. S. Geol. Survey, Washington, D. C....'45
Gardner, Louis W., Gulf Research & Devel. Co., Box 2038, Pittsburgh, Pa....'46
Garfias, Valentine R., Combustible, S. A., Cinco de Mayo, Mexico, D. F., Mex....'19
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Garlough, John L., consulting, 705 Fourth Natl. Bank Bldg., Wichita, Kan....'28
Garner, Aubrey H., DeGolyer & MacNaughton, 1000 Continental Bldg., Dallas, Tex....'19
Garnjost, Frederick W., Spuyten Duyvil, New York, N. Y....'21
Garrett, Julius Benjamin, Jr., Stanolind Oil & Gas Co., Box 3092, Houston, Tex....'35
Garrett, Melvin M., consulting, 1423 Republic Bank Bldg., Dallas, Tex....'21
Garrett, Robert J., Kerr-McGee Oil Industries, Inc., Kerr-McGee Bldg., Oklahoma City, Okla...'45
Garst, Jarvis, Union Oil Co. of Calif., 902 Tower Bldg., Jackson, Miss....'31
Gartner, James L., Seismograph Service Corp., Kennedy Bldg., Tulsa, Okla....'19
‖Garwood, Roland William, Socony-Vacuum Oil Co., Apt. Nacl. 1140, Bogota, Colombia, S. A..'40
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Gealy, Wendell B., Gulf Oil Corp., Box 1166, Pittsburgh, Pa....'26
Geis, Harold Lorenz, Barnsdall Oil Co., 2212 Esperson Bldg., Houston, Tex....'44
Geis, Wilfrid H., Union Oil Co., Union Oil Bldg., Los Angeles, Calif....'23
Gentry, Albert William, Long Beach Oil Devel. Co., 255 S. Santa Clara Ave., Long Beach, Calif...'39
Gentry, Howard L., consulting, 921 E. Michigan Ave., Jackson, Mich....'38
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George, W. O., U. S. Geol. Survey, Austin, Tex....'24
Georgesen, Niels Christian, Tide Water Assoc. Oil Co., Evansville, Ind....'39
Gerdes, Carl Herman, United Geophysical Co., Inc., 595 E. Colorado St., Pasadena, Calif....'39
Germany, Eugene Ben, E. B. Germany & Sons, Dallas, Tex....'26
‖Germond, Kenneth Work, Sun Oil Co., Brookhaven, Miss....'42
Gester, George C., Standard Oil Co. of Calif., 1129 Standard Oil Bldg., San Francisco, Calif....'20
‖Gester, Peter Warren, Richmond Explor. Co., Apt. 93, Maracaibo, Venezuela, S. A....'45
Gester, Stephen H., Standard Oil Co. of Calif., 1129 Standard Oil Bldg., San Francisco, Calif....'21
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Getzendaner, Frank M., independent, Yellville, Ark....'21
‖Geyer, Richard A., Humble Oil & Refg. Co., Houston, Tex....'43
Geyer, Robert Lee, Seismograph Service Corp. of Del., Apt. 1488, Caracas, Venezuela, S. A....'39
‖Gibbs, Byron Bennett, Union Prod. Co., Shreveport, La....'46
Gibbs, James F., consulting, 505 City Natl. Bank Bldg., Wichita Falls, Tex....'27
‖Gibson, Donald Thomas, Stanolind Oil & Gas Co., Box 660, Tyler, Tex....'38
Gibson, Eugene Ashley, Humble Oil & Refg. Co., New Orleans, La....'44
Gibson, Francis Alex, Iraq Petr. Co., Ltd., Box 309, Haifa, Palestine....'46
Gibson, George Drew, British-American Oil Prod. Co., Box 2649, Tulsa, Okla....'37
Gibson, George Randall, Richfield Oil Corp., Midland, Tex....'43
‖Gibson, Howard A., Pan-American Prod. Co., Mellie Esperson Bldg., Houston, Tex....'42
Gibson, Lee W., consulting, 2067 W. Garrey Ave., Baldwin Park, Calif....'45
Gibson, Worth C., Jr., Houston Oil Co., 1308 Slattery Bldg., Shreveport, La....'29
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Gierhart, Guy B., Humble Oil & Refg. Co., Box 1271, Corpus Christi, Tex....'28

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‖Gilbert, Orrin Wilfred, Standard Oil Co. of Calif., Los Angeles, Calif. '46
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‖Gill, Robert J., The California Co., 506 Union Natl. Bank Bldg., Wichita, Kan. '44
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Gillin, John A., National Geophysical Co., Dallas, Tex. '43
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‖Goodman, Herbert Maynard, Shell Oil Co., Inc., 2000 Alamo Natl. Bldg., San Antonio, Tex. '41
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‖Gray, George Robert, Baroid Sales Div., 11th Fl., Second Natl. Bank Bldg., Houston, Tex.....'45
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‖Hale, John Darrow, The Superior Oil Co., 930 Edison Bldg., Los Angeles, Calif.....'39
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‖Iles, George G., Jr., Union Sulphur Co., Inc., Sulphur, La.....'40
Illing, Vincent Charles, Imperial College of Sci. & Tech., London, S. W. 7, England.....'34
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Imbt, William C., Stanolind Oil & Gas Co., Box 1540, Midland, Tex.....'31
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Jackson, James Roy, Jr., Humble Oil & Refg. Co., 1405 Canal Bldg., New Orleans, La.....'38
Jackson, Ralph Semmes, Independent Explor. Co., 901 Esperson Bldg., Houston, Tex.....'42
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‖Jacques, Arthur N., Cities Service Oil Co., Wichita, Kan.....'43
‖Jager, Eric Howard, Stanolind Oil & Gas Co., Wichita, Kan.....'42
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‖James, Jay R., Dow Chemical Co., Commerce Bldg., Houston, Tex.....'41
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Jenkins, Page T., Carter Oil Co., Billings, Mont. '40
Jenkins, Philip, Kentucky-West Virginia Gas Co., Prestonsburg, Ky. '42
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Matson, Thomas Edwards, Pure Oil Co., Tulsa, Okla.....'40
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‖Matthews, Edwin Patterson, The Geotechnical Corp., Box 667, Riverton, Wyo.....'40
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Maxwell, Ross Allen, Big Bend Natl. Park, Marathon, Tex.....'30
‖Maxwell, William Byron, United Fuel Gas Co., Charleston, W. Va.....'47
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Vandiver, Vincent W., Seaboard Oil Co., 417 S. Hill St., Los Angeles, Calif....'20
Van Eaton, Raymond Andrew, c/o Mills Bennett, 3402 Gulf Bldg., Houston, Tex....'40
Van Gilder, H. R., Sohio Petr. Co., Box 359, Casper, Wyo....'24
†van Gogh, F. A. A., Zeekant 108 Schev., The Hague, Holland....'21
Van Melle, Francois Anthonie, Shell Oil Co., Inc., Box 2099, Houston, Tex....'36

‖Van Norden, Peter John, Socony-Vacuum Oil Co., 26 Broadway, New York, N. Y.....'45
Van Orstrand, C. E., U. S. Geol. Survey, Pekin, Ill.....'31
‖van Rossum, Otto, Mexican Gulf Oil Co., Box 106, Tampico, Tamps., Mex.....'45
‖Van Siclen, DeWitt Clinton, 264 Park Lane, Douglaston, Long Island, N. Y.....'45
Van Steenbergh, Samuel Kermit, Sinclair Prairie Oil Co., 901 Fair Bldg., Forth Worth, Tex.....'34
‖Van Tine, Arthur Benbrook, Colorado School of Mines, Golden, Colo.....'41
Van Tuyl, Francis M., Colorado School of Mines, Golden, Colo.....'22
van Weelden, A., N. V. de Bataafsche Petr. Mij., 30 Carel van Bylandtlaan, The Hague, Holland..'25
Van Zant, James H., Eason Oil Co., 1011 Fort Worth Natl. Bldg., Fort Worth, Tex.....'24
‖Vary, John A., Michigan Consolidated Gas Co., 47 N. Division Ave., Grand Rapids, Mich.....'47
Vaudoit, Paul L., Fifteen Oil Co., 2011 Esperson Bldg., Houston, Tex.....'26
Vaughan, Francis Edward, V. & E. Mfg. Co., 758 S. Fair Oaks Ave., Pasadena, Calif.....'23
Vaughan, T. Wayland, Rm. 427, U. S. Natl. Museum, Washington, D. C.....'26
‖Vaughn, Grady Henry, Jr., Spartan Drilling Co., 601 Dallas Natl. Bank Bldg., Dallas, Tex....'41
‖Vazquez, Andres Lopez, Petroleos Mexicanos, Apt. 705, Tampico, Tamps., Mex.....'41
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‖Verckler, Stewart P., Kansas State Highway Comm., Abilene, Kan.....'42
Vernon, Benton R., consulting, 303 Ricou-Brewster Bldg., Shreveport, La.....'38
Vernon, I. J., Coweta, Okla.....'25
Vernon, Jess, Amerada Petr. Corp., Box 2040, Tulsa, Okla.....'25
Vernon, Robert Orion, Florida Geol. Survey, Box 631-T, Tallahassee, Fla.....'46
Vertrees, Charles D., Continental Oil Co., Box 431, Midland, Tex.....'24
Ver Wiebe, Walter A., Univ. of Wichita, Wichita, Kan.....'19
Vesely, Leon Robert, Amerada Petr. Corp., 1811 Niels Esperson Bldg., Houston, Tex.....'38
Vetter, John M., Pan-American Prod. Co., 1245 Mellie Esperson Bldg., Houston, Tex.....'24
Vickery, Ward R., Vernon Oil & Gas Co., 214 Fourth Natl. Bank Bldg., Wichita Kan.....'28
Vieaux, Don George, U. S. Geol. Survey, 425 Denham Bldg., Denver, Colo.....'40
‖Vincent, Mordelo L., Jr., Vincent & Welch, Box 1427, Lake Charles, La.....'38
Vitt, Alfred Weston, Seaboard Oil Co. of Delaware, 417 S. Hill St., Los Angeles, Calif.....'37
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Vogler, Edward Allen, Shell Oil Co., Inc., 641 M. & M. Bldg., Houston, Tex.....'47
Voigt, Harold E., The Superior Oil Co., Oil & Gas Bldg., Houston, Tex.....'36
Vokes, Harold Ernest, Johns Hopkins Univ., Baltimore, Md.....'46
Volk, Russell H., Plains Explor. Co., Denver, Colo.....'42
Vonderschmitt, Louis, Geol. Pal. Institut, Bernoullianum, Basel, Switzerland.....'39
‖Von Eiff, Herbert C. Whittington, Salt Dome Oil Corp., Mellie Esperson Bldg., Houston, Tex...'40
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‖Wade, Wallace Lee, Humble Oil & Refg. Co., Mobile, Ala.....'41
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‖Wadsack, George E., Jr., Bridwell Oil Co. Box 1785, Wichita Falls, Tex.....'40
‖Wadsworth, Albert Hodges, Jr., American Smelting & Refg. Co., Box 822, Silver City, N. Mex....'41
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Waggoner, Eugene B., U. S. Bureau of Reclamation, Denver, Colo.....'43
Waggoner, Stephen Gose, independent, 422 First Natl. Bank Bldg., Wichita Falls, Tex.....'29
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Wagner, Carl D., consulting, 2259 S. Troost, Tulsa, Okla.....'39
‖Wagner, Cary Richard, Jr., Pure Oil Co., Box 2127, Amarillo, Tex.....'40
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Wagner, Clyde L., consulting, 2259 S. Troost, Tulsa, Okla.....'27
Wagner, J. Basil, consulting, Box 37, Chandler, Okla.....'27

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Waite, Stephen Temple, Satterton Rd., Exmouth, Devon, England.....'41
‖Walcher, Wayne E., J. M. Huber Corp., 302 Petr. Bldg., Wichita, Kan.....'40
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‖Walker, Edward Bullock, III, M. I. T. Graduate House, Cambridge, Mass.....'43
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Walker, Jule Hargis, The Chicago Corp., Heep Bldg., Corpus Christi, Tex.....'36
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Walker, William Lester, 328 Eighteenth St., Santa Monica, Calif.....'18
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Wallace, Don Lyle, Gulf Research & Devel. Corp., 422 E. Ninth St., Colorado City, Tex.....'45
Wallace, Louis Stacy, The Superior Oil Co., 2211 Apco Tower, Oklahoma City, Okla.....'40
Wallace, P. A., Ray Stephens, Inc., 2600 Apco Tower, Oklahoma City, Okla.....'36
Wallace, William Edwin, Jr., Sohio Petr. Corp., Atlas Bldg., Shreveport, La.....'39
Wallis, William E., International Petr. Co., Ltd., Apt. 1081, Lima, Peru, S. A.....'30
‖Walne, Walter Hillman, Jr., Moore Explor. Co., Box 753, Midland, Tex.....'46
Walpole, Leonard Whitworth, Compania Shell de Ecuador, Quito, Ecuador, S. A.....'41
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Walters, Mason G., Federal Power Comm., Washington, D. C.....'28
Walters, Ray A., Imperial Oil Co., Ltd., 301 Examiner Bldg., Calgary, Alta., Canada.....'36
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Wanless, Harold R., 234 Natural History Bldg., Univ. of Illinois, Urbana, Ill.....'32
Wantland, Dart, U. S. Reclamation Service, Denver, Colo.....'31
‖Ward, Dwight Edward, Carter Oil Co., Box 801, Tulsa, Okla.....'39
Ward, J. H. E., Mid-Continent Petr. Corp., Box 404, Shreveport, La.....'39
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‖Ward, Roland Van, Shell Oil Co., Inc., 965 First Natl. Bldg., Oklahoma City, Okla.....'41
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‖Ware, William Edmond, The California Co., 1818 Canal Bldg., New Orleans, La.....'45
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Warner, Ralph E., Forest Devel. Corp., 1229 Milam Bldg., San Antonio, Tex.....'31
Warren, Howard C., Ginther, Warren & Ginther, 1647 Esperson Bldg., Houston, Tex.....'28
Warren, John Edwin, Carl B. King Drilling Co., Box 270, Midland, Tex.....'37
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‖Webb, Edwin James, Gulf Oil Corp., Box 1166, Pittsburgh, Pa. '47
‖Webb, James A., W. B. Hinton Oil Co., 2900 Mercantile Bank Bldg., Dallas, Tex. '30
‖Webb, John Hanor, Faculty Exchange, Univ. of Oklahoma, Norman, Okla. '42
‖Webb, Kenneth Wilson, Amerada Petr. Corp., 614 Orpheum Bldg., Wichita, Kan. '46
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‖Webb, Sam Nail, W. C. McBride, Inc., 1904 Milam Bldg., San Antonio, Tex. '46
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Wells, Murray J., Cities Service Oil Co., Box 1251, Bartlesville, Okla. '39
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‖Welsh, David Lee, Sinclair Prairie Oil Co., Billings, Mont. '47
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‖Weltman, Louis H., Lion Oil Co., Tower Bldg., Jackson, Miss. '41
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West, William Ward, Lario Oil & Gas Co., First Natl. Bank Annex, Midland, Tex.....'35
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Westheimer, Jerome M., Simpson-Fell Oil Co., Ardmore, Okla.....'32
‖Westmoreland, Earl, Seaboard Cil Co. of Delaware, Ardmore, Okla.....'40
Westmoreland, Frank Smith, The Atlantic Refg. Co., Box 1346, Houston, Tex.....'34
‖Wethington, William O., Nash, Okla.....'30
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Wheeler, Carlton Wesley, Pure Oil Co., Fair Bldg., Fort Worth, Tex.....'43
‖Wheeler, James Albert, Deep Eddy Apts., 397-D, Austin, Tex.....'42
Wheeler, Joseph Bowen, Stanolind Oil & Gas Co., Jackson, Miss.....'44
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‖White, Albert William, Fain-McGaha Oil Corp., 607 Hamilton Bldg., Wichita Falls, Tex.....'42
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‖Wilsey, James Arthur, Jr., Princeton Univ., Princeton, N. J. '44
Wilshire, L. M., Skelly Oil Co., Box 1650, Tulsa, Okla. '23
Wilson, Arthur Noble, consulting, 915 Second Natl. Bank Bldg., Houston, Tex. '40
Wilson, Cedric Clark, Trinidad Petr. Devel. Co., Ltd., Palo Seco, Trinidad, B. W. I. '40
‖Wilson, Charles Lewis, 405 S. First St., Austin, Minn. '43
Wilson, Charles William, Jr., Vanderbilt Univ., Nashville, Tenn. '38
Wilson, Edward B., Sun Oil Co., Tyler, Tex. '22
Wilson, Eldred Dewey, Arizona Bureau of Mines, Univ. of Arizona, Tucson, Ariz. '46
‖Wilson, Ernest Bradley, Sterling Oil & Refg. Corp., 1709 Sterling Bldg., Houston, Tex. '41

Wilson, Eugene England, The Geotechnical Corp., Box 7166, Dallas, Tex. '40
Wilson, Forest Wayne, American Republics Corp., Petr. Bldg., Houston, Tex. '40
‖Wilson, George M., State Geol. Survey, 414 Natural Resources Bldg., Urbana, Ill. '43
Wilson, Ivan Franklin, U. S. Geol. Survey, Washington, D. C. '41
Wilson, James Ernest, Jr., Explor. Dept., Shell Oil Co., Inc., Box 2099, Houston, Tex. '40
‖Wilson, James Lee, 11 Henry St., East Haven, Conn. '44
‖Wilson, James Neff, Seismograph Service Corp., Box 1590, Tulsa, Okla. '43
Wilson, Joe G., The Texas Petr. Co., Apt. 267, Caracas, Venezuela, S. A. '31
Wilson, John H., independent Explor. Co., Fort Worth Natl. Bank Bldg., Fort Worth, Tex. '21
Wilson, Joseph M., independent, 707 Continental Bldg., Dallas, Tex. '22
Wilson, Louis R., Carter Oil Co., 1300 Apco Tower, Oklahoma City, Okla. '46
Wilson, Malcolm E., General American Oil Co., Dallas, Tex. '20
Wilson, Ralph Woodrow, Baroid Well Logging Service, Second Natl. Bank Bldg., Houston, Tex. '46
Wilson, Richard M., The Ohio Oil Co., Box 1120, Shreveport, La. '38
Wilson, Robert Rogers, consulting, 1565 Altivo Way, Los Angeles, Calif. '30
‖Wilson, Ruth Blanchard, The Atlantic Refg. Co., 1001 City Bank Bldg., Shreveport, La. '44
Wilson, Thomas C., Venezuelan Atlantic Refg. Co., Apt. 893, Caracas, Venezuela, S. A. '30
‖Wilson, Wallace Woodrow, California Research Corp., Box 721, Whittier, Calif. '45
Wilson, Walter B., Gulf Oil Corp., Box 661, Tulsa, Okla. '21
Wimbish, Forrest E., Magnolia Petr. Co., Box 1828, Oklahoma City, Okla. '28
Wines, Donald Bradford, Midstates Oil Corp., Tulsa, Okla. '29
Winfrey, Donald B., Petty Geophysical Engineering Co., Box 651, Casper, Wyo. '31
Wing, Robert Busch, Shell Oil Co., Inc., Box 1191, Tulsa, Okla. '38
Winham, W. P., Standard Oil Co. of Calif., 605 W. Olympia, Los Angeles, Calif. '28
Winkler, Bruno Oscar, Standard-Vacuum Oil Co., Rm. 648, 26 Broadway, New York, N. Y. '31
Winkler, Hans, Sun Oil Co., Box 1682, Midland, Tex. '31
‖Winkler, Virgil Dean, Creole Petr. Corp., Apt. 889, Caracas, Venezeuela, S. A. '40
Winter, Niles B., The Atlantic Refg. Co., Box 871, Midland, Tex. '24
Winton, Will M., Texas Christian Univ., Fort Worth, Tex. '20
Winzeler, Alvin Raymond, Stanolind Oil & Gas Co., Box 689, Jackson, Miss. '40
Wiringa, Leon Otis, Shell Oil Co., Inc., 2000 Alamo Natl. Bldg., San Antonio, Tex. '37
‖Wise, Henry Francis, United Geophysical Co., Box 809, Seminole, Tex. '42
Wise, James Sharples, Wise Drilling Co., Okmulgee, Okla. '42
‖Wishart, A. Paul, 211 Cross Valley Rd., Rt. 12, Knoxville, Tenn. '45
Wisser, Edward Hollister, consulting, 204 Sharon Bldg, San Francisco, Calif. '46
Wissler, Stanley G., Union Oil Co. of Calif., Box 511, Compton, Calif. '27
‖Witherspoon, Edgar, Witherspoon Finance Co., Ada, Okla. '40
Wofford, Henry Rollins, Jr., 231 W. Agartia Ave., San Antonio, Tex. '35
‖Wolcott, Richard Hastings, Sohio Prod. Co., Mt. Pleasant, Mich. '43
‖Wold, John Schiller, Barnsdall Oil Co., 2212 Esperson Bldg., Houston, Tex. '41
Wolf, Albert G., Texas Gulf Sulphur Co., 1009 Second Natl. Bank Bldg., Houston, Tex. '24
Wolf, George H., Keystone Explor. Co., Karnes City, Tex. '43
‖Wolf, Michael Walter, The California Co., 1006 U. S. Natl. Bank Bldg., Denver, Colo. '46
Wolff, Deane J., Kerlyn Oil Co., 2020 First Natl. Bldg., Oklahoma City, Okla. '23
‖Wolfram, Bertram, Jr., Seismic Explor., Inc., 2911 Gulf Bldg., Houston, Tex. '43
‖Wolverton, Harold A., Halliburton Oil Well Cementing Co., Waggoner Bldg., Wichita Falls, Tex. '41
Womack, Brame, Sohio Petr. Co., Box 1667, Shreveport, La. '34
‖Womack, Robert, Jr., Gulf Refg. Co., Box 307, Laurel, Miss. '45
‖Wonfor, John Stephen, Geol. Survey of Canada, Westmount, Quebec, Canada '47
‖Wood, Clint B., Wood & Hunt Drilling Co., Wichita Falls, Tex. '46
Wood, Fred E., Standard Oil Co. (Indiana), 910 S. Michigan Ave., Chicago, Ill. '24
Wood, George R., Geophoto Services, Inc., 305 E. & C. Bldg., Denver, Colo. '30
Wood, James T., Jr., The Texas Co., 929 S. Broadway, Los Angeles, Calif. '24
Wood, Jay Pendleton, Humphreys Gold Corp., 910 First Natl. Bank Bldg., Denver, Colo. '27
‖Wood, Mary C., Tide Water Assoc. Oil Co., Houston, Tex. '46
Wood, Owen Bishop, The Atlantic Refg. Co., Box 1346, Houston, Tex. '39
Wood, Robert H., Broswood Oil Co., 416 Beacon Bldg., Tulsa, Okla. '20
Wood, Virgil O., Broswood Oil Co., 416 Beacon Bldg., Tulsa, Okla. '20
‖Woodbury, Homer Olwin, The California Co., 1006 U. S. Natl. Bank Bldg., Denver, Colo. '42
Woodford, Alfred O., Pomona College, Claremont, Calif. '24
Woodman, Kermit Thomas, Sohio Petr. Co., 514 Bitting Bldg., Wichita, Kan. '46
Woodring, Wendell P., U. S. Geol. Survey, Washington, D. C. '43
Woodruff, Elmer Grant, U. S. Engineers, Tulsa, Okla. '19

Woods, E. Hazen, Sinclair Prairie Oil Co., Midland, Tex.....'25
‖Woods, Peter Gerald, Jr., Seaboard Oil Co. of Delaware, Bakersfield, Calif.....'45
Woods, Raymond Douglas, Humble Oil & Refg. Co., 1065 Humble Bldg., Houston, Tex.....'35
Woods, Robert E., General Petr. Corp., Los Angeles, Calif.....'45
Woods, Sam H., Sun Oil Co., Box 1348, Tulsa, Okla.....'25
Woodward, Albert Fletcher, Union Oil Co. of Calif., Union Oil Bldg., Los Angeles, Calif.....'38
Woodward, George Edward, Jr., Western Seismograph Supply Co., Oklahoma City, Okla.....'29
Woodward, Harold Robinson, independent, 1604 Fairmount, Wichita, Kan.....'25
Woodward, Jack Spurgeon, consulting, Republic Bank Bldg., Dallas, Tex.....'45
‖Woodward, Truman Pendleton, Carter Oil Co., Box 1739, Shreveport, La.....'39
Woodward, Walter Thomas, U. S. Geol. Survey, Taft, Calif.....'38
Woollard, George P., Woods Hole Oceanographic Inst., Woods Hole, Mass.....'45
Woolley, Glen C., Transwestern Royalty Co., 1630 Milam Bldg., San Antonio, Tex.....'28
†Woolley, John Bernard, Shell Oil Co., Inc., 1008 W. Sixth St., Los Angeles, Calif.....'46
‖Woolley, William Leeman, Mid-Continent Petr. Corp., Midland, Tex.....'44
*Woolnough, Walter George, c/o W. L. Woolnough, "Callabonna," Park Ave., Gordon, N. S. W., Australia.....'29
Woolsey, E. V., consulting, Box 268, Luling, Tex.....'20
Word, Charles Freeman, consulting, Box 2153, Abilene, Tex.....'38
Workman, Lewis Edwin, Illinois Geol. Survey, Natural Resources Bldg., Urbana, Ill.....'40
Worrell, Frank Hansen, The Ohio Oil Co., Chickasha, Okla.....'42
Wosk, Louis David, Aztec Oil Co., 1838 Lucile Ave., Los Angeles, Calif.....'24
*Wrather, William Embry, U. S. Geol. Survey, Washington, D. C.....'17
Wright, Andrew Clemmons, Shell Oil Co., Inc., Tyler, Tex.....'20
Wright, Fay Linton, consulting, 811 W. Seventh St., Los Angeles, Calif.....'27
Wright, Fred S., consulting, Box 1151, Midland, Tex.....'20
Wright, Hugh, 812 Subway Terminal Bldg., Los Angeles, Calif.....'30
Wright, Randall, Univ. of Illinois, Navy Pier, Chicago, Ill.....'35
Wright, Ray Harroun, Geophysical Service, Inc., 1311 Republic Bank Bldg., Dallas, Tex.....'38
Wright, Thomas Goodman, Stanolind Oil & Gas Co., 429 First Natl. Bank Bldg., Wichita, Kan.....'40
Wright, William Josiah, Dept. of Lands & Mines, Fredericton, N. B., Canada.....'42
Wyckoff, John Walter, consulting, 2954 Oakwood Dr., East Grand Rapids, Mich.....'35
Wylie, James R., Jr., Huntley & Huntley, 1207 Benedum-Trees Bldg., Pittsburgh, Pa.....'21
Wyman, Everett A., Amerada Petr. Corp., Box 2040, Tulsa, Okla.....'24
‖Wynn, Albert, MacMillan Petr. Corp., Box 411, El Dorado, Ark.....'41
Wynn, Warren H., Sinclair Prairie Oil Co., 7th Fl., Colcord Bldg., Oklahoma City, Okla.....'26
Wynne, Hal C., Phillips Petr. Co., Bartlesville, Okla.....'36
Wyszynski, Otton Wiktor Theissberg, consulting, 1396 N. Serrano Ave., Los Angeles, Calif.....'39

Yager, Charles E., Texas Pacific Coal & Oil Co., 2300 Fort Worth Natl. Bldg., Fort Worth, Tex.....'24
‖Yarborough, Hunter, Jr., Humble Oil & Refg. Co., Box 2180, Houston, Tex.....'39
‖Yates, Harvey Emmons, consulting, Box 397, Artesia, N. Mex.....'36
‖Yenne, Keith Austin, 37 Prentiss St., Cambridge, Mass.....'41
Yoakam, Coler A., independent, 1101 Petr. Bldg., Oklahoma City, Okla.....'22
Yoakam, Harlan Hunter, Plymouth Oil Co., Box 712, Sinton, Tex.....'29
Yoder, George M., Schlumberger Well Surveying Corp., Box 819, Laurel, Miss.....'43
‖Yolton, James S., Creole Petr. Corp., Tenblador Dist., Caripito, Venezuela, S. A.....'45
Young, Addison, consulting, First Natl. Bank Bldg., Midland, Tex.....'30
Young, Claude T., American Trading & Prod. Corp., Box 1727, Midland, Tex.....'27
Young, David Marion, Kentucky-West Virginia Gas Co., Prestonsburg, Ky.....'46
Young, Jackson S., Union Prod. Co., Shreveport, La.....'28
Young, John A., Jr., Syracuse Univ., Syracuse, N. Y.....'43
Young, John Chew, Conservation Comm. of Calif. Oil Prod., Los Angeles, Calif.....'46
‖Young, Keith P., Science Hall, Univ. of Wisconsin, Madison, Wis.....'44
Young, Raymond Owen, Trinidad Leaseholds, Ltd., Pointe-a-Pierre, Trinidad, B. W. I.....'42
Young, Umberto, Republic Petr. Co., 811 W. Seventh St., Los Angeles, Calif.....'28
‖Young, W. Ford, Colombian Gulf Oil Co., Apt. Nacl. 1339, Bogota, Colombia, S. A.....'45
Young, Wilber H., Jr., The Bradley Prod. Corp., Wellsville, N. Y.....'35
Youngmeyer, Ray, Amerada Petr. Corp., Box 2026, Tyler, Tex.....'21
‖Youngquist, Walter Lewellyn, Univ. of Iowa, Iowa City, Iowa.....'45
Younkman, Harry D., Sinclair Prairie Oil Co., Box 521, Tulsa, Okla.....'21
Yunck, George Feick, Pure Oil Co., Olney, Ill.....'39
‖Yust, Morton Ripley, 1214 S. Baltimore, Tulsa, Okla.....'45
‖Yzaguirre, Lauro Antonio, Lista de Correos, Cd. Camargo, Tamps., Mex.....'43

Zaba, Joseph, c/o D. D. Feldman, 802 First Natl. Bank Bldg., Houston, Tex.....'33
Zaikowsky, Michael Wladimir, Texas Petr. Co., Apt. 267, Caracas, Venezuela, S. A.....'43
‖Zapp, Alfred Dexter, U. S. Geol. Survey, Box 177, Univ. of New Mexico, Albuquerque, N. Mex.....'42
Zavoico, Basil B., consulting, 220 E. Forty-second St., New York, N. Y.....'25
Ziebold, William O., Spartan Gas Co., Box 766, Charleston, W. Va.....'29
Ziegler, Frederick McClain, Kern Oil Co., Ltd., Los Angeles, Calif.....'39
Zimmerman, Sam, Standard Oil Co. of Egypt., S. A., 22 Sharia Kasr el Nil, Cairo, Egypt.....'31
Zimmerman, Charles C., Keystone Explor. Co., Houston, Tex.....'31
Zimmerman, James Z., consulting, Delmont, Pa.....'22
‖Zimmerman, John, Jr., Permanente Cement Co., Permanente, Calif.....'44
‖Zinke, Ernest Clarence, 1715 Ave. N., Galveston, Tex.....'39
Zirbel, Nicholas Newton, Independent Explor. Co., 901 Esperson Bldg., Houston, Tex.....'46
Zoller, Lawrence J., Central Commercial Co., Box 2306, Tulsa, Okla.....'21
Zorichak, Joseph J., Rangely Engineering Comm., Rangely, Colo.....'24
Zuloaga, Guillermo, Standard Oil Co. of Venezuela, Caracas, Venezuela, S. A.....'37
Zunino, Juan Jose, Yacimientos Petroliferos Fiscales, Buenos Aires, Argentina, S. A.....'42

LIST OF MEMBERS AND ASSOCIATES GEOGRAPHICALLY ARRANGED

UNITED STATES

ALABAMA

ANDALUSIA—Larsen, Jack Kirby
AUBURN—Poor, Russell Spurgeon
BEATRICE—Randall, Walter
BIRMINGHAM
Toulmin, Lyman, Jr.
CAMDEN—Lorenz, Edmund Groff
CRAIG FIELD
Sartain, Maxwell Roland
MOBILE—Blackburn, Willis C.
Wade, Wallace Lee
MONROEVILLE
Hostetter, Harry Rudolph
MONTGOMERY—Jones, Walter B.
SPRING HILL—Merry, Edward T.
Ponder, John Lewis
SYLACAUGA—Sprengling, Kurt
TUSCALOOSA
Conant, Louis Cowles
Eargle, Dolan Hoye
Schoonmaker, George Russell
UNIVERSITY
Andrews, Thomas Gayleon
Higgs, William Reginald
LaMoreaux, Philip Elmer
McGlamery, Winnie
Richards, Edward Franklin

ARIZONA

MCKASKELL
Hampton, James David
PHOENIX—Brown, Silas C.
PRESCOTT
Creasey, Saville Cyrus
SCOTTSDALE
Jones, Edward L., Jr.
TEMPE—Culbert, James Irving
TUCSON
Dodge, Theodore Ayrault
Feth, John Henry
Hubbard, Bela
McKee, Edwin D.
Wilson, Eldred Dewey

ARKANSAS

EL DORADO
Dennis, Wilbert Chalmer
Dobie, Walter L.
Evans, Robert Pierce
Fahle, Paul Bartlett
Gaffney, John Edward
Hoke, Charles Jacob
Klinger, Edgar D.
Mackay, Donald K.
Meyer, Ruskin H.
Montgomery, Don D.
Rauch, Wayne C.
Seedle, Charles William
Wynn, Albert
FAYETTEVILLE—Giles, Albert
Payne, James Norman
FOREMAN—Kerr, John B.
HOT SPRINGS—Bean, Ward C.
HUNTSVILLE—Scott, Horace L.
LITTLE ROCK
Pendergraft, Robert Carl
MALVERN
Pond, Walter Franklin
TEXARKANA
Walton, George Goodrich
YELLVILLE
Getzendaner, Frank M.

CALIFORNIA

ALBANY, Pickrell, Daniel J.
ALHAMBRA
Stone, Richard O'Neill
ALTADENA
Harriss, Trewhitt Fairman
Whealton, Rowland G.
ARCADIA—Mayhew, Eldon Jay
ARVIN—Stockton, Frank R.
AVENAL—Klingaman, George L.
Knowlton, Drexel Robert
Roberts, Dwight C.
BAKERSFIELD
Anderson, Jack Q.
Augenthaler, Robert Lewis
Beach, John Hartwell
Beck, R. Stanley
Berryman, Raymond J.
Booth, William Norfolk
Brooks, Tennant Julian
Bryan, Joseph Jefferson
Capen, Maxwell Gary
Carlson, Stanley A.
Church, Harry Victor, Jr.
Cortright, William D.
Dana, Drexler
Darke, Roy E.
Davis, Donald McClure
D'Evelyn, Morton Naylor
Drennan, William Alvin
Ellsworth, Theodore Phelps
Erhard, Milo George
Ferguson, Glenn C.
Fitzgerald, Thomas J.
Fletcher, Roy William, Jr.
Forrest, Lesh C.
Green, Charles Frederic
Greenlee, Donald E.
Hackel, Otto
Hackett, Robert Snowden
Haines, Richard Bower
Harrington, Horace Eugene
Hatheway, Joseph Gilbert
Hewitt, Robert Leigh
Hill, Mason Lowell
Hill, Melvin James
Hornkohl, Frank
Howard, Paul Julian
Huey, Arthur Sidney
Hutcheson, R. Bellenden
Isberg, John T.
James, Wright Elwood
Jeffreys, Stanley Rex
Johnson, Floyd L.
Johnson, Rolfe Sherman
Jones, Anna Minkofsky
Kelley, Howard Allen
Kerr, Albert Ritz
Kilkenny, John E.
Kimble, James C.
Kleinpell, William D.
Krammes, Kenneth F.
LeConte, Joseph
Ledingham, Glen Wallace
Loy, Milton Edwin
Lupton, Benjamin Charles
Martin, Lois T.
Mathews, John William
Matjasic, Wallace Lee
May, Art R.
May, John C.
McGovney, Paul E.
McMasters, John H.
Millhauser, James D.
Moore, David A.
O'Flynn, James Baldwin
O'Keeffe, John, Jr.
Olson, John Walter
Payne, Max B.
Peterson, Arthur F.
Phillips, Ross Marvin
Pickett, Ed. S.
Popenoe, Hubert Lowell
Porter, Charles W.
Powell, William Eugene
Reese, Richard G.
Roth, George Helm
Saunders, Lowell W.
Scott, David Holcomb
Sheller, James Warner
Shoemaker, Richard W.
Snavely, Parke D.
Snedden, Loring B.
Sprague, Harry A.
Stinemeyer, Edwin H., Jr.
Stokesbary, Walter A.
Sturdevant, Rayman
Suverkrop, Lew
Vallat, Eugene H.
Van Beveren, O. F.
Warne, Archer Hurst
Weddle, Herman W.
Weidman, Robert McMaster
Wells, Robert Jackson
Woods, Peter Gerald, Jr.
BALDWIN PARK—Gibson, Lee W.
BERKELEY—Crook, Theo H.
Hulin, Carlton D.
Hurlbut, Elvin Millard, Jr.
Lawson, Andrew C.
Louderback, George D.
Uren, Lester C.
BEVERLY HILLS
Haenke, Martyn C.
Pellekaan, W. Van Holst
Shelton, Richard Cortez
CANOGA PARK
Kelsey, Frank B.
CAPITOLA
Williams, William A.
CHICO—Neumann, Fred R.
CLAREMONT—Crowell, John C.
Shelton, John Sewall
Woodford, Alfred O.
COALINGA—Bryan, Francis L.
COMPTON
Dorwart, George Martin
Fritz, Edward Blake
Wissler, Stanley G.
CONCORD
Heyl, George Richard
CULVER CITY—Alcorn, James M.
Holman, W. H.
EUREKA—Horton, Harold M.
FELLOWS
Kirkpatrick, Darrel L.
FRESNO—Allen, Devere F.
Hobe, Carl H.
Webb, Byron K.
GAVIOTA
Hollister, Joseph S.
GLENDALE
Anderson, James Burt
Gillan, Silas L.
Herold, Stanley C.
Van Couvering, Martin
HANFORD
Gribi, Edward A., Jr.
HOLLYWOOD
Gardner, A. Maclay
HUNTINGTON BEACH
Thomas, Clark Lee
HUNTINGTON PARK
Agee, Flint Humphrey
KING CITY—Ashauer, Hans F.
LAGUNA BEACH
Edwards, Everett C.
Foraker, William S.
Smith, Marcus Ayres J.
LA JOLLA—McCollom, C. R.
Shepard, Francis Parker
LONG BEACH
Albright, Charles C., Jr.
Armstrong, Ursel S.
Ballantyne, Richard S., Jr.
Bankhead, Charles C., Jr.
Campbell, Harry A.
Carlisle, Fredrick M.
Carrey, Albert A.
Chase, James L.
Cross, Rodman Kay
Ford, Robert Davis
Gentry, Albert William
Hill, Robert Cowdery
Kuffel, George Cole
Miller, Guy E.
Natland, Manley Leonard
Park, Stafford
Poland, Joseph F.
Porter, John Lewis
Preece, Rae
Pewett, Charles W.
Rothwell, William T., Jr.
Sinnott, Allen
Taylor, Dewitt E.
Ten Eyck, Warren E.
LOS ANGELES
Adams, Bradford C.
Anderson, Robert Edwin
Anderson, Robert Lee
Armstrong, Harold K.
Atwill, E. R.
Bailey, James P.
Baldwin, Thomas Armet
Barlow, Victor
Barnes, Roy M.
Barnes, Thomas Reed
Bartosh, Edmund J.
Beal, Carlton
Bear, Ted Lee
Bell, Gordon Rutledge
Benzley, James C.
Blodget, Ward B.
Bode, Francis Dashwood
Borax, Eugene
Born, Milton Charles
Bowes, Glenn H.
Bramlette, Milton N.
Bundy, Douglas
Burtt, John G.
Cabeen, William Ross
Carman, Ann Oakley
Carter, Frank B.
Cerini, William Ferdinand
Chambers, Lawrence Shiner
Chappuis, Louis C.
Clark, Harold Joseph
Clark, Robert W.
Clement, Paul F.
Clements, Thomas
Clute, Walker S.
Collom, Roy E.
Corby, Grant W.
Corey, William Henry
Crandall, Richard R.
Creed, James Gordon
Crosby, Arthur S.
Crown, Walter J.
Curran, John F.
Cutler, Willard W., Jr.
Davis, Elmer Fred
DeGoes, Louis Lellanne
deKoch, William G.
DeMaris, Elmer L.
Dennis, Terence Edwin
Detrick, Dana F.
Diven, Quay S.
Dorrance, James R.
Dresbach, C. H.
Driver, Herschel L.
Duff, Margaret Ellen
Durrell, Cordell
Earl, Glenn M.
Easton, William Heyden
Eaton, Joseph Edmund
Eckis, Rollin
Edwards, Merwin G.
Emery, Kenneth Orris
English, Leon E.
English, Walter A.
Erickson, Earling Lester
Evans, Louis H.
Fackler, John Henry
Feldmeyer, Arthur E.

Ferguson, R. N.
Ford, Waldo Emerson, Jr.
Fortine, Dwight H.
Fothergill, Harold Lawrence
Gale, Hoyt Rodney
Gardett, Peter H.
Gariepy, Glen Bernard
Geis, Wilfrid H.
Giffin, Wilson C.
Gilbert, Orrin Wilfred
Gilluly, James
Godde, Harry Anthony
Goudkoff, Paul P.
Grant, U. S., IV
Greene, Ray G.
Grinsfelder, Sam
Hale, John Darrow
Hall, Edward Abbott
Hall, Elwin B.
Hamill, James M.
Hamilton, Warren Bell
Handin, John W.
Harding, John W., Jr.
Hazzard, John Charles
Hillis, Donuil L.
Holston, Ashly Stanford
Hoots, Harold W.
Huber, John Norris
Ittner, Frank Edward
Jakosky, John Jay
Jensen, Joseph
Johnson, Clifton Wood
Johnson, Curtis Herman
Johnson, Harry R.
Johnston, Elizabeth Jane
Joujon-Roche, Jean Edward
Kelly, Robert Bowen
Kemnitzer, Luis E.
Kennett, William Eric
Killingsworth, Cecil Clair
King, Vernon L.
Kluth, Emil
Lackie, Opal Marie
Laiming, Boris
Lammers, Edward C. H.
LaPeire, George W.
Lebow, Ruth Young
Lee, A. Theodore
Lee, Harvey Willmonton
Lester, O. C., Jr.
Lewis, Milton W.
Lindsay, Robert English
Lockwood, Robert Bruce
Loel, Wayne
Long, Carl T.
Loofbourow, John S., Jr.
Macready, George A.
Mann, John F., Jr.
Matter, John Emerson
Mayuga, Manuel Nieva
McClellan, Hugh W.
McCloskey, Downs
McCollough, Edward H.
McConville, Robert John
McDowd, Edward L.
McMillan, John Robertson
McNaughton, Duncan A.
Mead, Roy G.
Mead, Roy Gibbons, Jr.
Metzner, Loyde Henry
Michelin, James
Miller, J. Charles
Miller, Robert H.
Minshall, Francis Edward
Moran, Robert B.
Moran, William Rodes
Morgan, Frank A.
Nelson, Loyal Edward
Nigra, John Oscar
Noble, Earl B.
O'Brien, Jerome Joseph
Ogier, E. H.
Oliver, Graydon
Osborne, Clarence B.
Osborne, Lee S.
Parker, Frank S.
Parks, Ernest K.
Patterson, Robert D.
Pemberton, J. R.
Porter, Lawrence Eugene
Porter, William W., II
Putnam, William Clement
Pyle, Howard Carter
Quinn, Robert V.
Rader, Harold E.
Rankin, Wilbur D'Arcy
Reed, Everett Taylor
Reel, Cecil E.
Rhoades, Roy S.
Riegle, John, Jr.
Rousselot, Norman A.
Ruth, John William
Salvatori, Henry
Schoo, Jan Hendrick
Shade, Nevin R.
Sheldon, Dean Howell
Sherman, Richard W.
Sickler, Jack M.
Siegfus, Stanley S.
Simmons, Rouse
Simon, Louis Joseph
Simonson, Russell Ray
Smith, Colin Hubbard
Smith, George J.
Smith, Hampton
Smith, Merritt B.
Smith, Wayne M.
Soper, Edgar K.
Stacy, Dean M.
Stanley, Everett Rollin
Steiny, Homer J.
Stewart, Irvine E.
Stewart, Sam
Stipek, Raymond J.
Stolz, Harry Phillip
Sullwold, Harold H., Jr.
Sumpf, Robert
Swayze, Ronald O.
Swords, Henry Leonard
Ten Eyck, Richard
Thornburgh, Hubert Robert
Torkelsen, O. I.
Travers, William J., Jr.
Triplett, Richard L.
Turner, Dale Edward
Tuttle, Helen Fowler
Valentine, William W.
Van Aken, Harrison Halleck
Vandenberg, Frederick E.
Vander Leck, Lawrence
Vandiver, Vincent W.
Vedder, Dwight G.
Vitt, Alfred Weston
Wadsworth, Francis Lowry
Wagner, Carroll M.
Waltman, W. DeWitt
Waterfall, Louis N.
Watson, C. P.
Watson, Elizabeth Anne
Wents, John Henry, Jr.
Wheatley, George York
Wheeler, August Edward
White, Robert Thompson
Williams, George C.
Willis, Cornelius G.
Willis, Robin
Wilson, Robert Rogers
Winham, W. P.
Wood, James T., Jr.
Woods, Robert E.
Woodward, Albert Fletcher
Woolley, John Bernard
Wosk, Louis David
Wright, Fay Linton
Wright, Hugh
Wyszynski, Otton Wiktor T.
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Young, Umberto
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Fu, Ch'eng Yi
Fuller, Oscar Kenneth, Jr.
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Gerdes, Carl Herman
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Gutenberg, Beno
Heald, Charles Leslie
Hoover, Herbert, Jr.
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Morris, Lawrence Kendall
Myers, Desaix B.
Robertson, George Kenneth
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Walter, Henry Glenn
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Pressler, Edward D.
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Turner, Johnathan D.
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Lester, John Lawrence
Mylius, L. A.
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Anderson, Thomas C. I.
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Cram, Ira H.
Hoffman, Arnold D.
Hopkins, James
Pettijohn, Francis John
Richardson, Eugene S., Jr.
Siever, Raymond
Sorrells, Warren Douglas
Taylor, Marilyn Louise
Thomas, Harold Scott
Wadell, Hakon A.
Wasson, Theron
Weller, J. Marvin
Williams, Lou
Wood, Fred E.
Wright, Randall
CHILLICOTHE—Edson, Fanny C.
EFFINGHAM
Bristol, Hubert M.

Luttrell, Homer H.
Potsch, John Peter

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Dapples, Edward Charles
Krumbein, William C.
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MARSHALL
Buehner, John Hubert
Donnelly, Clarence William

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Anderson, Rudolph Faraday
Bean, Beryl Kenneth
Beedle, Edward W., Jr.
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Crouse, George T.
English, Robert M.
Farmer, Paul
Harris, Lloyd Addis
Hirsch, Jack
Lewark, James Edward
Martin, Robert Henry
Melvin, Marlowe Douglas
Moses, Carl Edward
Mundorf, T. Dean
Richards, Ben Howard, Jr.
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Simonton, Owen W.
Smith, Donald Hoy
Turnbull, Wade William
Whiting, Lester Leroy

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Waterbury, H. Paul

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Mohler, Charles Edwin
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Obering, Ernest A.
Passel, Charles F.
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Rehn, Edgar Ernest
Smith, Julian W.
Tuck, Louis Lester
Wall, Thomas E.
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Pampe, Carl Frederick
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Whittinghill, Frank Thomas, Jr.

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SALEM—Hockman, James N.

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DeWolf, Frank W.
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Kline, Virginia Harriett
Leighton, Morris M.
Meents, Wayne Franklin
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Pullen, Milton W., Jr.
Scott, Harold William
Swann, David Henry
Townley, Enid
Wanless, Harold R.
Wilson, George M.
Workman, Lewis Edwin

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Galloway, Jesse J.

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Bounds, Bland David
Carman, Katharine W.
Combs, Edward Jolley
Cooper, Russell Calvin
DeLong, James Henry, Jr.
Eberle, Robert Francis
Ebmeyer, Gerard E.
Edwards, Hall
Egan, Martin G.
Elder, Stanley G.
Engel, Noel W.
Falletti, Antonio D.
Farrand, William Gardner
Georgesen, Niels C.
Hawn, Margaret Hayward
Honess, Charles W.
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Keller, Paul L.
Kemp, Edward Rogers
Latimer, Fred Hubert
Lewis, Kenneth W.
Nowlan, Harry H.
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Rogers, Maynard
Sackett, H. F.
Selover, Joseph Britton
Snider, George W.
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Ward, Roderick C.
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Woodward, Harold Robinson
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Bay, Harry X.
Baysinger, Eugene M.
Beeker, Ralph Edward
Bell, Douglas E.
Bennett, Robert Turner
Bescher, Earl H., Jr.
Bremer, Bernhard E.
Bricker, John F.
Broughton, Martin Napoleon
Brown, Leonard Irving
Calahan, Luther Weldon
Crandall, Kenneth H.
Crider, Lewis Calvin
Crosbie, James Morton
Daniel, Guy S.
Denny, Cyril Clayton
Dobrick, Edward G.
Effinger, William Lloyd
Everett, Robert Walter, Jr.
Ferebee, D. M.
Gibson, Eugene Ashley
Goerner, Fred Stephen
Hackbarth, Robert Earle
Hadley, Wade H., Jr.
Hickey, Harold N.
Hoover, J. Wilkinson
Howe, Ralph H.
Hudson, Joe Bailey
Jackson, James Roy, Jr.
Johns, Nooe Williams
Kilbourne, Lewis Perkins
Kipp, Earl Mathew
Little, Sterling E.
MacKnight, Frank Collester
Mayer, Maurice Joseph, Jr.
McCall, John Edmund
Nichols, Ernest Turnley
Norton, Richard D.
O'Bannon, Prentice H.
Orchard, Paul Joseph
Partridge, John Frederick, Jr.
Patton, Jacob L.
Petersen, Harluf C.
Petersen, Morton Qvistgaard
Peyser, Gladys Minette
Richardson, Felix Dorman
Richardson, H. T.
Schall, Fred Muller, Jr.
Schneider, G. W.
Shepherd, George Frederick
Smith, Neal Johnstone
Steinmayer, R. A.
Turner, Francis Earl
Utterback, Donald Desmond
Wall, Earle R.
Ware, William Edmond
White, William Harris
PARADIS—Failing, William E.
SHREVEPORT—Aimer, James D.
Arper, William B., Jr.
Barrett, William Morris
Bartell, Laurence D.
Barton, Louis A.
Beck, Robert W.
Beckman, Michael William
Berg, John Nelson
Blanchard, J. B.
Blanpied, B. W.
Borden, S. P.
Boyle, James Philip, Jr.
Brockway, E. R.
Brookings, Henry Nason Kinney
Bryan, Carl L.
Buchner, Harry M.
Cameron, Louis Gerin
Caster, Ermil Leslie
Chapman, Richard Thomas
Clark, Charles Chester
Clark, Chester C.
Clark, Samuel L., Jr.
Clark, Willis Kenley
Cochran, Phil K.
Corbin, Milton Wallace
Crow, Louis Milton
Davis, Gene O.
Drindak, Joseph Thomas
Eaves, Everett
Finch, Kenneth Day
Fischer, LeRoy Fred
Fischer, Victor Nathaniel
Forgotson, James M.
Fowler, Henry Florey
Frazell, William Davis
Freed, Richard
Gibbs, Byron Bennett
Gibson, Worth C., Jr.
Gilbert, A. C., Jr.
Goebel, Lawrence A.
Grage, Victor P.
Grigsby, Garland Oakes
Hamilton, Walter Frederick
Harlowe, Leslie S.
Hazzard, Roy T.
Hennen, Ray V.
Hickox, Charles Atwood
Howard, George Carl
Hunter, James W.
Hurry, Clare Nelson
Hutson, E. B.
Jackson, Alvin M.
Jenkins, George Marvin
Johnson, George Norris
Jones, John Percy
Kamb, Hugo R.
Kimball, Edgar W.
Lincoln, William Wilkinson
Lytle, J. Edward
Magale, John F.
Marshall, Walter Hill
Mayeaux, James Raymond
McCall, Charles Louis
McMahon, Joe Trees
McMullen, Donald John
Meltzer, Lee Hillard
Mix, Sidney E.
Moody, Clarence L.
Moody, John Drummond
Morris, James Howard
Murdoch, Ernest John
Ogier, Edwin Putman
Osment, Frank Carter
Pancake, Robert Evan
Parmelee, Edward Bruce
Philpott, Thomas Hughes
Plaster, William M.
Purzer, Joseph
Rank, Raymond A.
Ranney, William Elliot
Robinson, Van Daniel
Rosenkrans, Robert Russell
Rukas, Justin M.
Safonov, Anatole
Schwartz, Channing Beryl
Scott, Edward W.
Shamblin, William Earle
Simkins, J. J.
Spears, Walter H.
Spofford, Howard N.
Spooner, W. C.
Stevens, George R.
Stirtz, W. Melvin
Tash, George E.
Thomas, George Dewey
Tuttle, Frances
Tyson, John Edward
Valerius, Claude N.
Vernon, Benton R.
Wade, Rolla Theadore
Wagoner, George E.
Walker, James Edward
Wallace, William Edwin, Jr.
Ward, J. H. E.
Watson, John Gaul
Wells, William Matthew
Wender, W. G.
White, Morris Barksdal
Whitwell, E. V.
Williams, John Raynesford
Wilson, Richard M.
Wilson, Ruth Blanchard
Womack, Brame
Woodward, Truman Pendleton
Young, Jackson S.
SULPHUR
Baumgarten, Frederick A., Jr.
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Iles, George G., Jr.
Melsheimer, Albert Harry
Moore, James A.
Whatley, James Moulton
WEEKS—Anderson, Carlos O.

MARYLAND

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Dorsey, Geo. Edwin
Hamilton, Edward Alricks
Nance, Jack B.
Singewald, Joseph T., Jr.
Vokes, Harold Ernest
CHEVY CHASE—Darton, N. H.
Mendenhall, Walter C.
DARLINGTON—Iddings, Arthur
KENSINGTON—Reeves, Frank

MASSACHUSETTS

BOSTON—Haskell, Norman A.
La Croix, Morris F.
CAMBRIDGE
Cloud, Preston E., Jr.
Goodman, Clark
Mather, Kirtley F.
Ries, Edward Richard
Shrock, Robert Rakes
Walker, Edward B., III
Whitehead, W. L.
Williams, Edwin P.
Yenne, Keith Austin
LINCOLN—Tripp, Russell M.
MEDFORD—Lane, Alfred C.
NORTHAMPTON
Heminway, Caroline Ella
Meyerhoff, Howard Augustus
Shaub, Benjamin Martin
NORWOOD
Stone, Solon Wallingford
SHARON—Cushman, Joseph A.
SOUTH HADLEY
Willard, Max Emery
SPRINGFIELD—Robinson, Joseph
WELLESLEY—Parhiala, Leimo I.
WEST NEWTON
Butcher, William Sherman
Morgan, Charles Gill
WILLIAMSTOWN
Foster, Paul Woodward
WOODS HOLE—Hough, Jack Luin
Wollard, George P.

MICHIGAN

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Walsworth, Kenneth G.
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Buckwalter, Tracy V., Jr.
Cohee, George V.
Doeringsfeld, Walter W., Jr.
Eardley, Armand John
Ehlers, George Marion
Humphrey, William Elliott
Hussey, Russell Claudius

Kellum, Lewis B.
Landes, Kenneth Knight
Lovering, T. S.
CASSOPOLIS—Bishop, Margaret S.
CLARE—Cook, Everett Earl
GRAND RAPIDS
Knipe, Ralph E.
Newcombe, Robert J. B.
Smith, Robert Harlow
Vary, John A.
Weaver, Thomas James
Whitney, Paul B.
Wyckoff, John Walter
JACKSON—Gentry, Howard L.
LANSING—Boyd, Harold E.
de Cousser, Kurt H.
Eddy, Gerald Ernest
Grant, Rex Potter
Jodry, Richard Louis
Kelly, William Aultin
Martin, Helen M.
Vance, Thaddeus Blair
MIDLAND
Alquist, Francis Nelson
MT. PLEASANT
Branson, Edwin R.
Brinker, Willard Franklin
Brown, William F.
Chapman, Guy Edgar
Hubman, Ralph Gordon
Hunt, Raymond S.
Lewis, John Porter
Osgood, Manley, Jr.
Prout, Percy Lee
Schulz, William M.
Sleight, Glenn C.
Stewart, Norman Robert
Wolcott, Richard Hastings
MUSKEGON
Crider, Hugh Dixon
OWASSO—Melhorn, Ralph W.
PLEASANT RIDGE
Richards, Edith Jean
SAGINAW—Baltrusaitis, Edward J.
Clark, Charles Koogle
Gravelle, Kenneth Allen
Sanger, Willard A.
STERLING
Boling, Kenneth George

MINNESOTA

AURORA
Conwell, Cleland Neeper
AUSTIN—Wilson, Charles Lewis
MINNEAPOLIS
Donovan, Percy W.
Emmons, William H.
Swain, Frederick Morrill
Thiel, George Alfred
ST. PAUL—Carlton, Jane T.
ST. PETER—Johnson, Chester O.
VIRGINIA—Kendall, John M.

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Germond, Kenneth Work
Todd, James Hopkins
COLUMBIA—Calvert, Mont G., Jr.
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Lewis, Paul S.
JACKSON
Alagood, Robert Henson
Alexander, Clyde Wayne
Allen, Bryant W.
Ayres, Lewis Grant
Bailey, Clarence G.
Blanchard, Frank N., Jr.
Braunstein, Jules
Brown, John Lovelace
Buck, Charles E.
Copeland, Richard G.
Cox, Herbert Mack
Deuth, Martin John
Devlin, Frank
Emmerich, Harry H.
Ewing, Rudolph V.
Garst, Jarvis
Gosnell, George Edward
Grubb, Carl F.
Guest, Henry Grady
Harrell, David C.
Harris, R. Merrill
Harvey, Castle J. C.
Herring, Donald Grant, Jr.
Holden, Frederick Thompson
Huff, Jack Newton
Hughes, Urban B.
Jeffreys, Geoffrey
Kennedy, John B.
Kerlin, Marcellus L., Jr.
King, Robert E.
Kolvstad, Julie Anne
Knight, Wilbur Hall
McCarver, Alfred Gerald
McCasland, Barney C., Jr.
McFarland, L. R.
Meagher, David Pope
Means, John B., Jr.
Mellen, Frederic Francis
Michael, James F.
Monk, John Calhoun
Monsour, Eli T.
Moore, William Willard, Jr.
Morgan, Cecil L.
Morton, Robert Brading
Murray, Grover, Jr.
Neely, Joseph
Norman, M. E.
Pattison, William Harold
Pavlovic, Robert
Payne, Willard M.
Perry, Waynard Burton
Priddy, Richard Randall
Punches, Richard Knapp
Reese, Donald M.
Rice, Elmer M.
Schmidt, Karl A.
Schmotzer, Julius William
Scruggs, Maurice Dale
Sherwin, Melville William
Siberts, Carl Edwin
Spooner, Knight Keith
Sprague, Robert D.
Spyres, Herbert Lee
Stephenson, Cuthbert D.
Storey, Joseph Burnette
Talley, Gilbert Arthur
Thomas, Emil Paul
Thompson, John P.
Toler, Henry N.
Uri Joseph John
Weltman, Louis H.
Wheeler, Joseph Bowen
Winzeler, Alvin Raymond
LAUREL—Carter, Keegan
Green, George Gardiner
Lanier, Joseph Richard
Manger, G. Edward
McGlothlin, Tom
Otts, James Allen, Jr.
Womack, Robert, Jr.
Yoder, George M.
MERIDIAN
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NATCHEZ
Gulmon, Gordon Wesley
UNIVERSITY
Brown, Glen Francis
Morse, William C.
WIGGINS
Henderson, Marion Reece

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Hardy, Roy P.
Keller, Walter David
Mehl, M. G.
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Echols, Dorothy Jung
HIGGINSVILLE
Leonard, Clarence Ziegler
JOPLIN—Fowler, George M.
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Ball, John Rice
Brown, Robert Wesley
Burt, Roy A.
Lee, Marvin
Smith, Rufus McBride
PLATTE CITY—Abbey, Gerald E.
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Born, Kendall E.
Cowie, Roger Harrison
Forrester, James Donald
Graser, Frederick Arthur
Greene, Frank C.
Muilenburg, Garrett A.
Ostrander, Allen Roys
Robertson, Forbes Smith
Summerson, Charles Henry
SPRINGFIELD
Smith, Ralph Emerson
ST. LOUIS
Gross, Henry Emmett
Hinchey, Norman Shreve
Stearn, Noel H.

MONTANA

BILLINGS—Berg, Karl A. E.
Bramlette, William Allen
Chamberlain, Virgil Ralph
Cronin, K. Stewart
Dockery, Willard Lyle
Dudley, Paul H.
Fellows, Robert Arthur
Fulton, Loris J.
Hadley, Herbert David
Hornung, Arthur C.
Jenkins, Page T.
Marshall, Jesse William
Neiler, William Dixon
Paterson, Robert
Rogers, Carl Pembroke, Jr.
Rosenfeld, Melvin Arthur
Shay, D. C.
Sloan, Raymond D.
Thurman, Franklin A.
Welsh, David Lee
BOZEMAN—Foley, Edward J.
CUT BANK—Burns, Russell W.
Hupp, John Ervin
McCourt, James H.
Sullivan, Albert Martin
GLASGOW—Hudgens, Clyde O.
GREAT FALLS—Alpha, Andrew G,
Bateman, Andrew Frank, Jr.
Beer, George William
Erdmann, Charles E.
Peden, William M.
MISSOULA—Nash, Howard F.
SHELBY—Blixt, John Elmer
Saterdal, Alfred

NEBRASKA

AGATE—Cook, Harold J.
LINCOLN—Folger, Anthony
Lugn, Alvin Leonard
Reed, Eugene C.
Scherer, Oliver J.
Schramm, E. Frank
Waring, Gerald A.
OMAHA—Johnston, Floyd T.
Melvin, John Harper
Pelto, Chester Robert

NEVADA

RENO—Cree, Allan

NEW JERSEY

FORT MONMOUTH
Johnson, Edward William
FRANKLIN—Williams, William P.
NEW BRUNSWICK
Bowles, Edgar Oliver
Hayes, Albert O.
McCampbell, John Caldwell
PLAINFIELD
Kammerer, John Craig
PRINCETON—Duncan, Donald C.
Fox, Steven Knowlton
Kriz, Stanislav Jaroslav
Maxwell, John Crawford
Sampson, Edward
Sims, Paul Kibler
Thom, W. T., Jr.
Wilsey, James Arthur, Jr.
SPRING LAKE—Stillwell, James H.
TRENTON
DeBuchananne, George D.

NEW MEXICO

ALBUQUERQUE
Hoover, William B.
Johnson, Carlyle D.
Kelley, Vincent C.
MacAlpin, Archie Justus
Murphy, Robert Emmett
Umbach, Paul Henry
Zapp, Alfred Dexter
ARTESIA—Aston, Charles A., Jr.
Bloomfield, R. A., Jr.
Lamb, Noel Raymond
Scott, Wilton Elege
Sheldon, Vilas P.
Yates, Harvey Emmons
BENNETT—Baer, Daurice Frank
CARLSBAD—Baker, John Seaward
Branson, Carl C.
Cathcart, James Bachelder, Jr.
Frenzel, Hugh N.
Harley, G. Townsend
King, Ralph Hughes
Pratt, Wallace E.
Riggs, George D.
Warren, Walter Cyrus
Wills, Neil H.
FARMINGTON
Davis, Wesley Edward
HOBBS—Boss, Reuel Lee
Cahill, Edgar D.
Decker, Edith Marguerite B.
Madera, Fred
Miller, Charles Parmer
Moore, Joe Hiram
Petsch, Arthur H.
Russell, Harry Jones, Jr.
Sands, Charles Dudley
Staley, C. Glenn
JAL—Davis, William Kenneth
Nelson, Paul Hugh
LOCO HILLS
Krouskop, Norman W.
LOVINGTON
Brinnon, William B.
ROSWELL—Barnett, John Abner
Cave, Harold Sergius
Crandall, Roderic
Dunn, David Arthur
Headley, Joseph B.
Helmig, Phillips Dobbs, Jr.
Hruby, Milton
Kelly, John Martin
Stipp, Thomas F.
SANTA FE
Spurrier, Richard Ross
SILVER CITY
Wadsworth, Albert Hodges, Jr.
SOCORRO—Bates, Robert Latimer
Northup, Richard Cox
Vorbe, Georges
Wilpolt, Ralph Henry

NEW YORK

ALBANY—Myers, Clay Kenton
BRONXVILLE—Naramore, Chester
BUFFALO—Reeves, John R.
DOUGLASTON
Thompson, Lester S.
Van Siclen, De Witt Clinton
ENDICOTT—Bartle, Glenn G.
GLOVERSVILLE—Olsson, Axel A.
HAMILTON—Childs, Orlo E.
Unkesbay, Athel G.
ITHACA—Harris, Gilbert D.
Nevin, Charles M.

Palmer, Katherine V. W.
Ries, Heinrich

NEW YORK—Adams, Clyde B.
Aldrich, Henry R.
Baker, Norval E.
Baker, Raymond F.
Barnwell, George F.
Bartlett, Fred W.
Behre, Charles H., Jr.
Berg, Ernest L.
Bishop, Robert Alexander
Bleecker, Edward S.
Brice, John W.
Brokaw, Albert D.
Bronner, Finn Eyolf
Burnett, Jerome B.
Bush, Frederic A.
Case, William B.
Chapin, Theodore
Christie, Laurence G.
Cobb, Margaret C.
Cole, Edwin G.
Condit, D. Dale
Coryell, Horace N.
Cotner, Victor
Cox, Wesley Philip
Crum, Harry E.
Curtice, A. Arthur
Davis, Robert J.
Dixon, A. Faison
Donohoo, Horrie Van Waldo, Jr
Drake, Nels D'Arcy
Dresser, Myron A.
Eagles, Homer M.
Ellis, Brooks Fleming
Estabrook, Edward L.
Fagginger-Auer, Willem A.
Fath, A. E.
Fischer, Alfred George
Garnjost, Frederick W.
Greig, Douglas A.
Grove, Brandon Hambright
Hake, Benjamin F.
Hamilton, Charles W.
Hawley, Luther David
Haynes, Winthrop P.
Hedberg, Hollis D.
Herold, John Sublett
Heston, J. Ed
Hill, Kenneth E.
Hindes, E. P.
Holman, Eugene
Jablonski, Eugene
Jones, Verner Everett
Kalb, John L.
Kaufmann, Godfrey F.
Kay, Marshall
Kinney, Harry D.
Knebel, G. Moses
Knutson, Clarence J.
Kraft, Philip
Langlois, Alice
Larkin, John Jennings, Jr.
Leibensperger, Raymond
Lilley, Ernest R.
Link, Walter K.
Lovejoy, John M.
McCobb, Harry Wendell
McCollum, Leonard F.
McCulloch, Joseph P.
McKee, H. Harper
McQueen, Henry S.
Messina, Angelina Rose
Millard, William J.
Miller, William Dana
Milstein, M.
Moore, Thomas Verner
Moulton, Gail F.
Munoz, Robert Redman
Neal, Earl Seaton
Newell, Norman D.
Newhouse, Lester
Notestein, Frank B.
Olson, Walter S.
Paige, Sidney
Pertusio, Serge M.
Peterson, Jahn Jean
Pogue, Joseph E.
Pyre, Augustin
Reed, Lyman C.
Rieber, Frank
Rohrer, George H.
Sauve, Nathaniel Bernard
Schwennesen, Alvin T.
Sealey, Fred C.
Sherman, Roger H.
Skeels, Dorr Covell
Small, Walt Madison
St. Clair, Stuart
Stebinger, Eugene
Strock, Lester William
Suman, John R.
Sun, Chien-Chu
Taylor, M. Hall
Taylor, Ralph E.
Thalmann, Hans E.
van der Linden, B. H.
Van Norden, Peter John
von Estorff, Fritz E.
Walters, Ray P.
Wasson, Harold J.
Weeks, Lewis G.
Weichert, Rudolph F., Jr.
West, Donald Milton
Whetsel, Raymond Victor
Whiton, Herman F.
Winkler, Bruno Oscar
Zavoico, Basil B.

POUGHKEEPSIE
Warthin, Alfred S., Jr.

ROCHESTER
Jenks, William Furness

SCHENECTADY
Rhodes, Edward J.

SYRACUSE—Apfel, Earl T.
Young, John A., Jr.

WELLSVILLE
Whorton, Chester D.
Young, Wilber H., Jr.

WHITE PLAINS
Lewis, J. Volney
McCann, Franklin Thresher

NORTH CAROLINA

CHAPEL HILL
Huddle, John Warfield

DURHAM—Berry, Edward Willard

KINSTON—Stamey, Roderick A.

MANTEO—White, Kessack D.

WILMINGTON
Riggs, William Adams

NORTH DAKOTA

GRAND FORKS
Laird, Wilson Morrow

OHIO

CINCINNATI
Caster, Kenneth E.
Rich, John L.
Rittenhouse, Gordon

CLEVELAND—Johnson, Walter
McCloy, Walter Lowrie, Jr.
Mehta, Abdul Khaliq
Robinson, J. French
Smoots, John P.

CLIFTON
McCullough, A. Stafford

COLUMBUS
Cottingham, Kenneth
Lockett, J. R.
Norling, Donald L.
O'Rourke, Edward Vincent
Ring, Dewitt T.
Spieker, Edmund M.
White, George Willard

FINDLAY—Berwald, W. B.
Donnell, James C., II
Dumbros, Nicholas George
Emery, Wilson B.
Funk, Fred J.
Kurtz, Robert G.
Noble, Gilbert W.
Shade, E. Bruce
Thomas, George Terrell
White, Stanley Battershill

LIMA—MacDonell, James A.

NEWARK
Sparks, Jackson Bennett

TOLEDO
Applegate, Margaret Jayne
Lindberg, George David

OKLAHOMA

ADA—Barcklow, John Calvin
Bonifield, Henry Lease
Jones, Boone
Rixleben, Bruno
Witherspoon, Edgar

ANADARKO—McNally, Perry M.

ARDMORE—Bartram, Paul L.
Callahan, Drury V.
Clowe, Charles E.
Fell, Harold B.
Hannum, Connelly Edgar
Johnson, William R.
Kendall, Richard G.
Kline, Robert Walter
Milner, Charles A., Jr.
Neighbor, Frank
Neustadt, Walter, Jr.
Rose, Stanford Leland
Schweers, Frederick Paul
Stotler, Raymond Tracy, Jr.
Thomas, Murrell D.
Tomlinson, Charles W.
Westheimer, Jerome M.
Westmoreland, Earl
White, Maynard P.

BARTLESVILLE
Absher, William F.
Ambrose, A. W.
Baldwin, Harry L., Jr.
Bradley, Richard Moriss
Brasted, Fred
Brown, H. Travis
Charles, Homer H.
Clark, Robert P.
Courtier, William H.
Dietert, Arthur E.
Elliott, George R.
Ericson, Harry Berkeley
Felts, Wayne Moore
Given, Robert Jennings
Graham, B. L.
Harper, Paul Ashton
Hier, Charles Douglas
Hintze, Alma Jones
Isaacs, Elizabeth A.
Isenberger, Nate P.
Johnson, Holger Olin
Jones, Daniel John
Kaveler, Herman Henry
Kidd, Robert L.
Lounsbery, D. E.
Mallory, William Wyman
McCoy, Alexander Watts, III
Miller, Vincent
Moss, Rycroft G.
Murphy, P. C.
Owen, Herman J.
Reid, Robert P.
Sands, J. M.
Stucky, Zenas E.
Sutherland, Pat Kennedy
Thompson, Edwin Ivor
Van Dall, John E.
Weeks, Warren B.
Weirich, T. E.
Wells, Murray J.
Wilhelm, Arthur K.
Wynne, Hal C.

BIXBY—Cumming, Alfred

BRISTOW—Cantrell, Peggy F. P.

CEMENT—Becker, Robert More

CHANDLER—Wagner, J. Basil

CHICKASHA
Fee, Samuel Thomas
Langford, Eldon Woodrow
Langford, Lucille E. T.
Muir, J. Lawrence
Pincomb, Edwin Moats
Stones, James Eugene
Worrell, Frank Hansen

COWETA—Vernon, I. J.

DUNCAN—Boone, Dan Eugene
Clark, Roswell Dale
Davis, Clyde E.
Dawson, William Aubrey
Gouin, Frank
Hogan, William Roy, Jr.
Montgomery, Phil C.
Putman, Darrell M.
Reynolds, Jordan K.
Smalley, Claire F.
Swanson, Raymond H.
Tapper, Wilfred B.

EDMOND—Miller, Harry A.

EL RENO
Glover, Robert Howard

ENID—Clifton, R. L.
Earl, Will F.
Ford, Carl S.
Lillibridge, Harry E.

HEALDTON—Hamner Francis M.

HENRYETTA—Morris, Walter W.

HOBART—Russom, Vaughn W.

HOLDENVILLE
Minahan, James Leo

KETCHUM—Tandy, J. Hiram

KONAWA—Jordan, J. B.

MADILL—Brillhart, Norman, W.
Northrip, Gerald Albert

MARLOW—Relf, George O., Jr.

NASH—Wethington, William O.

NELSON—Bryan, Frank

NORMAN—Akers, Wilburn Holt
Carver, George E., Jr.
Cloud, Wilbur F.
Coleman, Tom L.
Davis, Leon Virgil
Decker, Charles E.
Dott, Robert H.
Fowler, Virginia Tolbert
Fox, Frederick Glenn
Fredericksen, Edward Arthur
Gould, Charles N.
Ham, William Eugene
Harris, Reginald Wilson
Huffman, George G.
Hussey, Keith Morgan
Laird, Joe Alex
Lucas, Elmer Lawrence
McClain, Forrest Milton
McNutt, Gordon Russell
Melton, Frank Armon
Monnett, V. Elvert
Moore, Carl Allphin
Oakes, Malcolm C.
Polk, Thomas Robb
Renfroe, Charles A.
Rogers, William Donald
Webb, John Hanor
Williams, Norman Francis

NOWATA—Kerr, James Lee

OILTON—Anderson, Oscar S., Jr.

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Abbott, Wayne R.
Alexander, Joseph Watrous
Amstutz, Platte T., Jr.
Anderson, Carl T.
Atkinson, William H.
Baldwin, Benjamin Franklin
Bale, Hubert E.
Ballard, William Norval
Barrett, Henry Haldred
Becker, Theodore G.
Beuck, William Frederick
Biggart, Robert William
Billings, Sam Glen
Brauchli, Rud W.
Brewer, John Edward
Brown, Vergil Neal
Bunte, Arnold S.
Burress, George Howard
Butcher, Sheldon D.

Buttram, Frank
Calvert, Warren Lytle
Camp, Richard W.
Canfield, Charles Reiter
Carpenter, M. E.
Clark, Charles R.
Clinkscales, Albert S.
Cole, Mary Jane
Conkling, R. A.
Cooper, C. Harrison
Crockett, Harry Lee
Curtis, Lawrence Wilford
Dahlgren, Elmer George
Dannenberg, R. M.
Decker, Willis Mansfield
Dorr, Clyde H.
Downing, Roswell B.
Dunn, George V.
Durham, James Harmon
Earle, Francis, Jr.
Edmund, Rudolph William
Ellison, Kenneth A.
Engleman, Rolf
Everett, Rizer
Faust, Josef
Fillmore, Ralph L.
Frizzell, Mildred V. Armor
Galloway, George Harold
Garrett, Robert J.
Gisburne, John Robert
Goudy, Louis Willard
Green, Thomas Henning
Hadler, Harry George
Hammonds, George Scott
Hancock, Bob
Hawkes, Wendall Homer
Henderson, Dorothy Jane
Hicklin, Richard Stuart
Hicks, Ira Curtis
Hill, V. G.
Hoagland, R. Lloyd
Hoard, John Lucian
Hoffman, Charles C.
Holmes, Vernon E.
Hoover, F. Mabry
Howard, Dan O.
Hyatt, Don L.
Janovy, Frank
Janovy, John
Jenkins, Harold D.
Johnston, John C.
Jones, Leland W.
Jones, Roy D.
Kate, Frederick Henry
Kautz, Archie R.
Kerns, Floyd G.
Kister, Herbert H.
Kite, William C.
Kleen, Harold J.
Koch, Thomas W.
Laughbaum, Graydon Howard
Laughlin, Roland W.
Lindner, Joseph Leicht
Maddox, Gerald C.
Maples, Steve Campbell
McAninch, Roy David
McBee, William Dalton, Jr.
McGee, D. A.
McKinley, Glenn Ernest
McMurtry, Wilbur Earl
Metcalf, Myron C.
Meyer, Robert Frederick
Miller, Willard L.
Montgomery, A. J.
Morales, Gilberto Garcia
Moreman, Walter L.
Mull, J. A., Jr.
Newby, Jerry B.
Nichols, Paul B.
Norville, Glen S.
Nuckolls, William Carlisle
Ohern, D. W.
O'Keeffe, Hugh W.
Owen, Elwyn Ronald
Parker, John Marchbank
Pasquella, George Graham
Perrine, Irving
Pollard, Robert T.
Price, Edgar William
Ramsey, Charles E.
Rankin, Horace Ellis
Rassinier, Edgar A.
Reavis, George David
Richards, A. Howard
Richards, J. T.
Riise, John Anderssen, Jr.
Roberts, Richard Lee
Rumsey, Edward W.
Sanford, John Theron
Sears, Joseph McHutchon
Selk, Erwin L.
Shields, Fred C.
Simmons, Kenneth A.
Stratton, J. Lynn
Strothmann, Frederick Henry
Suffield, Harry Franklin
Swesnik, Robert Malcolm
Swirczynski, Richard Paul
Taylor, Charles H.
Taylor, Jack Allen
Trombla, Lynn Burdeaux
Turk, Lon B.
Wallace, Louis Stacy
Wallace, P. A.
Ward, Roland Van
Ware, John McKee
Weintz, Clement A.
Wellman, Dean C.
Wheeler, Robert Reid
Williams, George O.
Wilson, Louis R.
Wimbish, Forrest E.
Wolff, Deane J.
Woodward, George Edward, Jr.
Wynn, Warren H.
Yoakam, Coler A.

OKMULGEE
Wise, James Sharples

PONCA CITY
Athy, Lawrence F.
Boyd, W. Baxter
Clark, Glenn C.
Clark, Stuart K.
Hunter, Robert E. Lee
Hurd, E. Gordon
Hurd, Harry H.
Iversen, William G.
Messman, Roger Lawrence
Mills, R. van A.
Morgan, D. M.
Parker, Everett C.
Prescott, Harold Raymond
Prokesh, Hugh E.
Royds, James Stanfield

PRAGUE
Klabzuba, Robert Ernest

PURCELL—Blanchard, W. Grant

SAPULPA—Brehm, Ralph C.
Cartmell, William Martin

SEMINOLE—Ketterer, Walter P.
Runyan, E. L.
Smith, Frederick James

SHAWNEE—Artman, George W.
Brown, Robert
Buck, Richard D.
Burke, Doyle Michael
Campo, Henry Andrew
Carpenter, Everett
Cassingham, Robert L.
Damon, Frederic Thomas
Davies, Jack W.
Dawson, Edwin A.
DeLong, James Alfred
Ditsworth, Glenn William
Gahring, William Ross
Graham, Will Lee
Hoyle, Charles R.
Kelly, Elmo Lee
Larson, Wilbert Sanford, Jr.
Meyer, Arthur M.
Mousley, Virginia Marcelle
Quiett, Roy C.
Rau, Harold L.
Smith, Delbert Franklin
Tyler, Henry Johnson

STILLWATER—Corrigan, Glen Lee
Ellison, Charles W.
Stump, Mark Eugene
Tarver, Earl A.

SULPHUR
Cross, Margaret Alice T.
Poirier, Otto Arthur
Powell, Luther Clinton

TULSA—Ackers, A. L.
Adams, W. C.
Albert, Emil Richard, Jr.
Anderson, Tom A.
Andrews, Harry Hugh
Arnold, Harry H., Jr.
Arnold, Henry C.
Arnold, Lincoln Merchant
Austin, Arthur Cecil
Bace, A. C.
Bailey, Willard F.
Bellou, Albert Lorenzo
Barrett, Lynn Wandell
Barthelmes, Albert J.
Bartram, John G.
Bates, Robert Paul
Baum, Robert
Beck, Elfred
Becker, Herman Carroll
Bednar, William Carr
Beekly, Albert L.
Bennett, Frank Orville
Bernard, W. E.
Berry, Harry Louis
Bevan, Thomas Judson
Bishop, Francis Luther
Bloesch, Edward
Bohart, Philip H.
Bolyard, Garrett L.
Born, William Theodore
Bowser, William F.
Brant, Ralph A.
Brown, Frank E.
Brown, Henry Wilder
Brown, Merritt H.
Bryant, Howard S.
Buckstaff, Sherwood
Bullard, Edgar F.
Burke, William Henry
Busch, Daniel Adolph
Butt, William Horace
Campbell, Francis Faulkner
Carlson, Charles G.
Carter, Roland White
Case, Leslie C.
Caylor, Garth William
Chapman, Martin Edward
Chickering, Wallace Wylie
Christenson, Alton Carl
Clark, Frank Rinker
Clark, Howard
Clark, Joseph M.
Clark, L. W.
Clarke, Ralph L.
Clayton, Neal
Clote, Thomas Anthony
Coffin, R. Clare
Collins, Jack Beverly
Conhaim, Howard J.
Copass, Jack M.
Cornelius, Lee Henri
Coryn, F. R.
Crain, John Richard
Cullen, Ronald J.
Davies, James Dudley
Davis, Sidney Hugh
Deegan, Charles J.
Deisenroth, Malcolm, Jr.
Denison, A. Rodger
Devin, Fred A.
Dickey, Parke A.
Dillard, W. Reese
Dille, Glenn Scott
Eckenwiler, Cleo W.
Egan, John A.
Ehler, Allen
Eirich, Constance G.
Ellis, John Reese
Ellsworth, Elmer William
Elson, William H.
Emrick, D. G.
Evans, Noel
Feagin, Barney, Jr.
Ferguson, John L.
Ferris, Craig
Fienning, Robert Louis
Finfrock, Lawrence Johnson
Finley, Jean Carson
Fitts, L. E., Jr.
Fitzgerald, Paul E.
Forsyth, Roderick James
Frossard, Robert L.
Frost, Victor LeRoy
Fruehling, Siegfried William
Fuller, Melville Weston
Galley, John E.
Gardner, James H.
Gartner, James L.
Gawthrop, R. M.
Gibson, George Drew
Gilbert, Thomas Harold
Gill, Joseph Powers
Gilmour, Andrew
Giltinan, George Murray
Ginter, Roy LaMont
Gish, Wesley G.
Glass, Wilson Vernon
Graeber, Clyde Provolt
Green, William Gladstone
Griffith, Glenn R. V.
Grigsby, R. B.
Griley, Horace L.
Grimm, George A.
Guffey, Vernon E.
Guthrey, William Morris
Hall, Dollie Radler
Hamilton, Robert G.
Handley, Ernest Jack
Hannum, Robert Charles
Harlton, Bruce H.
Harris, Seward F.
Hart, Raymond M.
Hatcher, Oscar
Hawes, Julian
Hawkins, Allen Gentry
Hawkins, Glenn D.
Hengst, Jess H.
Henry, William Wirt
Hestbeck, Marion E.
Hewett, Charles Francis
Hill, Orval Hall
Hoffmeister, William S.
Hoke, T. C.
Holston, Alvin Arthur
Hoover, James B.
Hopper, Walter E.
Horkey, William E.
Horner, William L.
Hosterman, John F.
Houghton, Herbert Moore
Howell, Jesse V.
Hower, S. Grace
Hughes, Richard
Hull, Joseph P. D.
Hunt, Lenora May
Hutchinson, Edward Allen
Innes, Arland Irving
Jameson, Paul Marvin
Johnston, Leslie Alexander
Jones, Charles T.
Kapner, Harvey Herbert
Kauffman, James S.
Kennedy, Joseph Brady, Jr.
Kennedy, Luther E.
Keplinger, Charles Henry
Kezeler, James Linden
Kiess, Myron C.
Kimball, Kent K.
King, Charles C.
Kisling, James W., Jr.
Kittredge, Frank R.

Knappen, Russell S.
Koenig, Ralph A.
Kramer, William B.
Kravis, Raymond F.
Kridler, George M.
Kunsman, Howard Smith
Lamar, Lee C.
Lambert, Gerald S.
Lane, Charles W.
Langenheim, Ralph Louis, Jr.
Larkin, Pierce
Laves, U. R.
Leach, Thomas W.
Leavitt, William Bradbury
Leibrock, Robert M.
Leiser, J. B.
Leonard, John Reeves
Lewis, Jerry Burton
Lilienborg, Burton Armand
Littlefield, Max S.
Longmire, William R.
Lukert, Louis H.
Lyons, Paul L.
Maher, John C.
Markham, Edmond O.
Markley, Elmer A.
Marmaduke, Richard Calvin
Marshall, Lester Ray
Martens, Willis Pershing
Matson, Thomas Edwards
Maverick, Phillip
Mayes, Tom D.
McClure, Clair Edmond
McCrary, E. W.
McCready, Harry Joseph, Jr.
McEachin, Wright Daniel
McGirl, James N.
McHugh, James W.
McIntyre, Paul J.
McMillen, Raymond F.
McMorris, William A., Jr.
Merritt, John W.
Mershon, Milton M.
Miller, Burford Maxwell
Miller, E. Floyd
Miller, Wendell Z.
Millikan, Charles V.
Millison, Clark
Moffatt, Robert J.
Moore, Homer Clarence
Moore, Horatio L.
Morero, Joseph E.
Morley, Harold T.
Mosburg, Lewis G.
Moses, Harold F.
Mossman, Reuel Wallace
Mumford, Clarence Scott
Murphy, James K.
Murray, Albert N.
Musselman, George Abraham
Naffziger, Luther Orlando
Neal, Eugene Preston
Nelimark, John H.
Neumann, L. Murray
Newman, Thomas F.
Nufer, D. C.
Oliphant, A. G.
Oliphant, Charles W.
Page, Charles Newton
Pakiser, Louis Charles, Jr.
Palmerston, Stewart Colin
Parr, Arnold Foster
Patton, Roger R.
Peabody, Harlan W.
Phelps, Frederick G.
Piggott, Guido M., Jr.
Pilkinton, Edgar Merrill
Porterfield, Robert R.
Price, Sylvan S.
Rae, Colin C.
Redfield, John S.
Reed, George Wylie
Reeves, James E.
Reisher, Paul H.
Renfro, Harold Bell
Reno, Duane H.
Reynolds, Karl W.
Richards, Raymond
Richardson, Carl B.
Riggs, Robert J.
Roark, Edward L.
Roark, Louis
Roark, Ralph B.
Robeck, Raymond Clifton
Roberts, Francis Archibald
Roberts, M. C.
Roemer, Cletus Daniel
Rogers, Andrew J.
Ross, Charles M.
Ross, Ralph B.
Rupnik, John J.
Rutledge, Richard B.
Ryniker, Charles
Scott, H. M.
Scott, Vernon C.
Seaman, L. O.
Shakely, Ed.
Sharpe, Joseph Audley
Shea, Edward F.
Sherry, William J.
Shutt, Roscoe E.
Sidwell, Carroll Vincent
Silverman, Daniel
Simpson, Richard Walker, Jr.
Sinclair, William B.
Siverson, Garfield C.
Smith, Gerald N.
Snow, Dale R.
Snow, Robert Dale
Solliday, Albert LaFayette
Spangler, Grant W.
Stevens, Freeland Howard, Jr.
Stiles, Aden Edmund
Stoner, O. E.
Strachan, Clyde G.
Sullivan, Chris Rice
Sype, William Russell
Tappolet, W. A.
Tarr, Russell S.
Taylor, Garvin L.
Taylor, Victor Jean
Teis, Maurice R.
Templeton, James B.
Thompson, James William
Tillotson, Allen W.
Toomey, Charles Calvin
Travis, Abe
Truex, Arthur F.
Tucker, Bill Curtis
Tucker, Reese Herrick
Tuttle, Richard Carol
Upp, Jerry E.
Vernon, Jess
Waering, Erik Norman
Wagner, Carl D.
Wagner, Clyde L.
Wails, Elmer Dennis
Walker, Lucian H.
Walters, Robert F.
Wanenmacher, Joseph M.
Ward, Dwight Edward
Watson, Joseph D.
Weatherby, Benjamin B.
Weimer, Frank G.
Weingartner, R. A.
Welch, Virgil H.
Wells, Samuel W.
Wescott, Lois Regina
Westby, Gerald H.
White, Kirk Schroder
Whitney, Fred L.
Widess, Moses B.
Wilcox, Stanley William
Willis, S. Morse
Wilshire, L. M.
Wilson, James Neff
Wilson, Walter B.
Wines, Donald Bradford
Wing, Robert Busch
Wood, Robert H.
Wood, Virgil O.
Woodruff, Elmer Grant
Woods, Sam H.
Wyman, Everett A.
Younkman, Harry D.
Yust, Morton Ripley
Zoller, Lawrence J.

WADE—Goodman, P. W.

WALTERS
Barlow, Maerlant M.

WEWOKA—Stoker, Carl E.

WOODWARD—Chesney, Robert W.

OREGON

HILLSBORO
Anderson, Richard J.

PORTLAND—Allen, John Eliot
Baldwin, Ewart Merlin
Hodge, Edwin T.
Stewart, R. E.

SCIO—Paschall, Robert Henry

SEASIDE
McCosh, Bonnie Enderud

PENNSYLVANIA

BRADFORD—Eckert, Frank E.
Fralich, Charles Eugene
Harding, Richard Walter
Heck, Edward T.
Hughes, Richard V.
Shoemaker, William Morris
Simmons, Arthur Carlisle
Stephens, Maynard Moody

BRYN MAWR—Dryden, Lincoln

COUDERSPORT
Cole, Adna Malone

CYNWYD—Putlitz, Fritz Helmuth

DELMONT—Zimmerman, James Z.

HARRISBURG
Stephenson, Robert C.

OIL CITY—Secor, Donald T.
Seifert, Wilbur H.

PHILADELPHIA—Giles, John M.
Guntz, Henry Anthony
Harris, Richard C.
Helis, James
Lindsly, Ben E.
Mason, John Frederick
Richards, Horace Gardine
Weeks, Albert W.
Weeks, Herbert J.
White, Tell Thompson

PITTSBURGH
Allen, Frank Tilbury
Allon, Meyer Michael
Aszklar, Stanley J.
Backman, John Edward
Bassett, Charles F.
Baxter, John C.
Bayles, Robert Ellery
Brankstone, Hugh R.
Bristley, Leon Prestridge
Brockway, LeValley Irving
Cox, Benjamin Burton
Davis, Ralph E.
Eckhardt, E. A.
Feldmiller, Charles Henry
Fettke, Charles R.
Finn, Fenton Harrison
Foster, Alden W.
Galey, John Taylor
Galpin, Sidney Stewart
Gardner, Louis W.
Gealy, Wendell B.
Goodman, John Vollmer
Grow, George Copernicus, Jr.
Gulley, M. Gordon
Hanson, William E.
Hastings, Wynne K.
Heald, K. C.
Huntley, Louis Grow
Huntley, Louis Guy
Ingham, Albert Irwin
Jones, Robert William
Kerbow, Russell B.
Lang, Ralph H
McGrew, Harry Johnson
Melchior, Louis Francis
Meszaros, William Andrew
Newlon, John Hawker
Patnode, Homer Whitman
Rand, Wendell P.
Rhoades, Ralph O.
Robinson, W. Bernard
Sherrill, Richard E.
Somers, Ransom E.
Swain, James Fulton
Vance, Warner R.
Watson, George R.
Webb, Edwin James
Wendenburg, Otto
Wylie, James R., Jr.

PORT ALLEGANY—Gaddess, Jack

SEWICKLEY
Lilligren, Jonathan M.

STATE COLLEGE
Amyx, James W.
Crowl, George Henry
Griffiths, J. C.
Krynine, Paul D.
Pirson, Sylvain J.

WYNNEWOOD
Mahoney, Roger Sylvis

RHODE ISLAND

PROVIDENCE
Jeffords, Russell M.

SOUTH CAROLINA

CHARLESTON
Watkins, Joe Henry

COLUMBIA—Buie, Bennett Frank

SOUTH DAKOTA

BELL FOURCHE—Durr, John F.

CUSTER—Page, Lincoln Ridler

LAKE ANDES
Underwood, Lloyd B.

RAPID CITY—Gries, John Paul
Tullis, Edward Langden

VERMILLION—Baker, Charles L.
Petsch, Bruno Carl
Rothrock, E. Paul

TENNESSEE

COLUMBIA—Butters, Roy M.

DOVER—Howard, W. V.

KNOXVILLE
Moneymaker, Berlen C.
Wishart, A. Paul

NASHVILLE
Ferguson, Herman W.
Glenn, L. C.
Hageman, John Andrew
Sheppard, Charles Wilcox
Whitlatch, George Isaac
Wilson, Charles William, Jr.

TEXAS

ABILENE—Anderson, Robert G.
Barnes, A. E., Jr.
Boehms, Eugene Field
Brodie, Gerson Herzl
Byram, John Perkins
Conselman, Frank Buckley
Day, James Reneau
Dickerson, Charles Herbert
FitzGerald, Norman D.
Funkhouser, E. M.
Graham, Paul Douglas
Hall, Ellis A.
Martin, Benjamin Herbert
Maxwell, Riley G.
McCollum, Aubrey Britton
McFarland, Earl R.
Miller, Powell Wesley
Morrison, Robert Emmett
Nowels, Kenneth B.
Olson, Odell Cecil
Perini, Vincent C., Jr.
Rodan, William Bird
Shirk, Wilmer Ray
Smith, Claude Dinkins
Straughan, George M.

Tims, Vergil E.
Williamson, Harry
Word, Charles Freeman

ALBANY—Jones, Alva Vance
Stasney, Herman R.

ALICE
Davidson, John Perryman
Franks, Robert M.
Lind, Charles McClelland
Rossebo, C. B.
Short, Richard T.
Stein, Ira H.

ALLEYTON
Griffith, Cunningham L.

AMARILLO—Britt, Harry Max, Jr.
Craig, T. C.
Doshier, Achille Wicks
Erickson, Arthur R.
Eyoub, Leila Lisette
Ferguson, Carlos Mose
Fosshage, Ernest Willard
Gude, Leo J.
Gutru, Robert James
Hagy, Lawrence R.
Hinson, Howard Houston
Lanyon, Ronald Kenneth
Mallory, Robert William
Meholin, Graydon L.
Moxey, Walter G.
Notley, William E.
Oles, Lawrence M.
Paschal, Elisha A.
Peterson, Clarence J.
Rusk, Willard W.
Sisney, Everett Weston
Thawley, Leonard Herman
Thompson, James D., Jr.
Wagner, Cary Richard, Jr.

ANDREWS
Cheesman, Beynon Sale

ANSON
Fountain, Henry Coleman

ARLINGTON
McNulty, Charles L., Jr.

ATHENS—Morgan, Aubrey Austin

AUSTIN—Barnes, Virgil E.
Broadhurst, William L.
Bullard, Fred M.
Burke, Ray Albert
Burnett, Thomas Jefferson, Jr.
Bybee, Hal P.
Byram, Ronald W.
Damon, Gordon,
Dante, John Henry
Eifler, Gus Kearney, Jr.
Elliott, John E.
Frizzell, Donald Leslie
George, W. O.
Goldich, Samuel Stephen
Herald, Frank A.
Horton, Claude Wendell
Hughes, Darrell Stephen
Hughes, Richard John, Jr.
Livingston, Noyes B.
Lonsdale, John T.
Marquez, Gustavo
Power, Harry H.
Rabensburg, Newton J.
Redfield, Robert Crim
Rodgers, Jack Pinknea
Roston, Joseph Paul
Sellards, E. H.
Seward, Clay Luzenberg, Jr.
Sewell, Janet Hoover
Snider, L. C.
Stenzel, Henryk B.
Trout, Kye, Jr.
Waddell, Richard Kent
West, Norman Neal
Wheeler, James Albert
Whitney, F. L.

BEAUMONT
Bartlett, C. Lothrop
Beck, Bryan D.
Braugh, Donald D.
Cagle, Joe Maxwell
Claypool, C. B.
Denton, Harold
Durgan, Herbert Leonard
Hopkins, Richard Holmes
Justice, Philip S.
La Touche, John D.
Pack, R. W.
Parker, Herbert
Pool, Frank Morrow
Rangeler, Wallace William
Roberts, Marion Stanton
Schroeder, Kingsley V.
Siegel, Frank

BEEVILLE—Barnett, D. G.
Fletcher, Claude Osborne
Gully, Philip D.
Hancock, J. M.
Miller, David M.
Senseman, Ralph Burdette
Shayes, Fred P.
Smith, Fred E.

BELLAIRE—Fuqua, Marjorie C.
Holliday, Samuel
Niven, Robert N.

BIG LAKE
Harkey, William Jarrott

BIG SPRING
Barnes, Chester F.
Keller, Ray F.

BORGER—Dana, P. L.
Hemsell, Clenon C.

BRECKENRIDGE
Dodson, Edward Auld
Ferrero, Clarence F.
Kingston, Benson Madill

BRENHAM—Houston, Sam H.
Turner, George Raymond

BRYAN—Rodgers, John Albert

CAMERON—Robinson, B. F.

CISCO—Reeves, J. R.

COLEMAN—Cheney, M. G.

COLLEGE STATION
Burt, Frederick A.
Graham, Joseph J.
Lynch, Shirley Alfred
Rasmussen, William Charles
Russell, William L.
Vance, Harold
Waidhofer, Joe John

COLORADO CITY
Wallace, Don Lyle

CORPUS CHRISTI
Benson, Dale L.
Bocock, Oscar Lafayette
Bong, Carl P.
Buck, Cleo Eugene
Burke, James Dan
Cardwell, William Henry
Chaddick, William Monroe, Jr.
Chalupnik, Elsie Bernardine
Clark, James Tate
Collier, John J., Jr.
Colson, William Edward
Cooke, Henry Clay
Denham, Waitus Kay, Jr.
Frericks, Alvin Louis
Fryou, Joe A.
Gierhart, Guy B.
Greenman, Wilber Eugene
Haas, Charles Frederick
Hansell, James Myron
Hendrickson, Robert D.
Hudson, Oscar McDonald
Jolley, Durward N.
Major, Millard Holland
Maley, Willis A.
McCallum, Henry D.
McCammon, John Henry, Jr.
McClain, Orville Graves
McGuckin, Glenn Merle
Metts, Dean Francis
Miller, Carroll C.
Minton, Joseph Weber
Olson, Walter Sigfried
Owens, Frith C.
Parrish, Gaston H.
Pinkley, George Roger
Poole, John Clifton
Price, W. Armstrong
Rich, Estus Buford
Ross, Donald Alexander
Sargent, Elwood Cather
Seevers, Harris N.
Smith, Floyd Clayton
Sullivan, John Wentworth
Taegel, Edwin A.
Thomas, Norman L.
Travis, Joe Johnson
Walker, Jule Hargis
Walker, Lincoln Abraham

CORSICANA—Wells, Harris P., Jr.
Willis, Vernon Howe

CRANE—Harris, Roy
McClure, Harold Yokum

CUERO—Steen, Charles Augustus

DALLAS—Agnich, Fred J.
Albritton, Claude Carroll, Jr.
Allen, E. G.
Anderson, George Harold
Arnold, Kingsland
Aronson, Sam M.
Autry, Vernon E.
Baker, Malcolm E.
Beers, Roland F.
Bostick, J. Wallace
Brantly, John E.
Bright, Richard Thatcher
Briscoe, Glenn O.
Brooks, Olin D.
Brown, Augustus Bart
Burchard, Frederic L.
Burg, Kenneth Edwin
Burress, Walter M.
Byrd, David Harold
Carpenter, Charles B.
Carter, Devere V.
Cesinger, E. F.
Clark, John W.
Clawson, William W.
Clifford, O. C., Jr.
Cobb, Howard L.
Collingwood, D. M.
Conley, J. N.
Coombs, John Robert
Cortes, Henry C.
Cram, Edward C.
Crawford, David J.
Crichton, Jack Alston
Cunningham, Benjamin A., Jr.
Davis, Roger Hugh
DeGolyer, E.
Denton, Frank Roy
Deputy, Paul R.
Doering, John
Dougherty, Jack Francis
Dunlap, Robert Craig, Jr.
Estergren, Edmund Frederick
Esunas, Bernard Joseph
Farrow, Benjamin Darwin
Ferguson, Marion Lee
Fisher, Barney
Fisk, Frank Karr
Frost, Jack
Gaby, Ewin D.
Garner, Aubrey H.
Garrett, Melvin M.
Germany, Eugene Ben
Gillin, John A.
Gilmore, Kathleen K.
Graham, Gordon Lloyd
Grant, Drane Fones
Gray, Alfred
Gray, William Ramsay
Green, Cecil Howard
Gruy, Henry Jones
Guthrie, Robert Keith
Hager, Dilworth S.
Hamilton, Irving Boyd
Hamm, W. Dow
Hard, Edward W.
Harmon, Edward Coleman
Headington, Clare Wesley
Heath, Francis E.
Henderson, John Blythe H.
Heroy, William B.
Heroy, William Bayard, Jr.
Hill, Harry B.
Hurt, Edwin Estill
Joekel, Fred E.
Johnson, Dorothy
Jopling, Don Winter
Karcher, John C.
Keathley, Kathleen Stephens
Keeler, Clifton M.
Kelsey, Lewis O.
Kelsey, Martin C.
Kendrick, Frank E.
Knox, T. K.
Kohler, Gustave John, Jr.
Kraus, Edgar
Lahee, Frederic H.
Lancaster, L. Kenneth
Langton, Claude M.
Lewis, James Albert
Ley, Ross Henry
Lloyd, Abe M.
Logue, Lester Lloyd
Love, Perry R.
MacNaughton, Lewis W.
McCarver, Holland C.
McCoy, George Young
McCoy, James Roy
McDermott, Eugene
McFarland, Paul W.
McFarland, Russell S.
McKay, Alexander Ewing
McLeod, Angus
Menefee, James C.
Meredith, Carlton
Meyer, Willis G.
Miller, Lloyd Eugene
Moore, Gilbert Parvin
Moore, William Bishop
Morgan, Henry J., Jr.
Murrell, John Herbold
Nash, Paul E.
Neal, Kathleen S.
Newton, William Wilson
Norton, George H.
Oden, Arthur Jack
Oldham, Albert E.
Osborne, Paul F.
Packard, Sidney A.
Parker, Jack Adriance
Patterson, Archibald B.
Pernell, James Herbert
Perryman, James Dale
Peterson, Hazel Agnes
Pittman, Chalmers Van A.
Porter, Phil
Powell, Ralph S.
Puzin, Lucien A.
Ralston, Wallace
Ransone, William Robert
Reagor, Edward C.
Reeves, Frank W.
Rettger, Robert E.
Rice, George Baker
Rider, Charles R.
Roberts, Louis C., Jr.
Robinson, Heath M.
Rogatz, Henry
Rose, Harrison W.
Rouse, John Thomas
Ruley, Eugene Evan
Russ, Leon F.
Russell, Philip G.
Schultz, Frank August
Schwarz, Melbert E.
Sclater, Kenneth C.
Seale, Robert I.
Shugart, Thomas R.
Shuler, Ellis W.
Smith, Eugene Wilford
Smith, Stanley Laurence
Snyder, Raymond W.
Spencer, Morris Grady
Stehr, Raymond A.

Stevens, Nelson Pierce
Storm, Alfred E.
Sturdevant, John M.
Taylor, Cyril B.
Taylor, Surce John
Teas, Paul C.
Teufel, Virgil Willard
Thomas, Earl
Thompson, Sheridan A.
Tottenham, Woodson Miller
Trostel, Everett G.
Tygrett, H. V.
Umpleby, Joseph B.
Vanderpool, Harold C.
Vaughn, Grady Henry, Jr.
Vogel, Felix A., Jr
Walton, Oscard Edward
Waters, James A.
Webb, James A.
White, Rex Harding
Wilcox, Fred H.
Williams, Charles Coburn
Wilson, Eugene England
Wilson, Joseph M.
Wilson, Malcolm E.
Woodward, Jack Spurgeon
Wright, Ray Harroun

DEL RIO—Dinsmoor, Carlton G.

EASTLAND—Perkins, Joseph M.
Steel, Robert J.

EDINBURG—Coel, Eustace J.
North, Lloyd

EL PASO—Nelson, Lloyd A.
Williams, George Arthur

FALFURRIAS—Hamilton, James R.
Porter, Frederick C.

FALLS CITY—Powell, Ezra H.

FORT STOCKTON
Fulk, Frank Floyd

FORT WORTH—Abbott, Earl O.
Abbott, John L.
Adkisson, Albert W.
Allen, Alton C.
Aurin, Fritz L.
Balbin, Paul Davet
Bass, Perry R.
Bayer, H. M.
Benton, Louis B.
Berger, Walter R.
Berger, Walter R., Jr.
Bradfield, Herbert H.
Bradish, Ford
Brown, J. Earle
Buttermore, Paul M.
Buttram, William A.
Casteel, Sanford H.
Champion, Oscar R.
Christie, Robert S.
Christner, D. D.
Claiborne, Ray E.
Clark, H. Smith
Cordry, C. D.
Cox, Virginia Jackson
Crump, John R.
Cummins, Ralph H.
Dally, Claude Franklin
Dana, Richard Harry
Dean, David P.
Dean, P. C.
Donoghue, David
Dudley, Raymond W.
Ellis, George L.
Farmer, Russell
Fash, Ralph H.
Fisher, Gordon Henderson
Freedman, Louis H.
Gardner, Edgar Jackson
Gideon, Leroy
Goodrich, Robert D.
Grant, Paul A.
Gregory, Peter Paul
Grubbs, David M.
Ham, William Otis, Jr.
Harris, Sidon
Harvey, William W.
Hendricks, Leo
Hord, John Alan
Hudson, William A.
Hunzicker, Ashley Andrew
Hyde, Clarence E.
Johnson, James F.
Kornfeld, Sam
La Neve, R. O.
Lee, Lynn K.
Ley, Henry A.
Lovejoy, J. B.
Markley, Joseph H., Jr.
Merkt, Ernest Edward, Jr.
Morris, James Lynn
Nicol, David
Nolte, William J.
Normand, Spencer Raphael
Nugent, Laurence Earl, Jr.
Phipps, Joseph B., Jr.
Pishny, Charles H.
Poulsen, Frank E.
Powers, Elliot H.
Raish, Henry Gustav
Renaud, Charles L.
Renfro, Millicent Aloyse
Ricks, Francis Maurice
Romine, Thomas B.
Rowser, Edwin M.
Sale, Clarence M.
Sanders, C. W., Jr.
Schouten, Franklin H.
Schweers, Richard Henry
Scott, Gayle
Stookey, Donald G.
Tapp, Theodore Leland
Thomas, J. Elmer
Thompson, Benedict E.
Thompson, R. R.
Thomsen, Erik
Upson, M. E.
Van Steenbergh, Samuel Kermit
Van Zant, James H.
Wahlstrom, Edwin Arthur
Warren, Lincoln Edgar
Wheeler, Carlton Wesley
Whisenant, J. Barney
White, Luther H.
Williams, John Blaine
Wilson, John H.
Winton, Will M.
Yager, Charles E.

FREEPORT
Herrington, Louise H.
Sampson, Charles Milburn

FREER—Quarles, Miller W., Jr.

GAINESVILLE—Lynn, Robert H.
Swick, Leo Emmett, Jr.
Thomas, William T.

GALVESTON—Candela, Alvin
Hull, Arthur M.
Zinke, Ernest Clarence

GEORGETOWN
Blank, Horace Richard

GONZALES
Bybee, Robert William

GRAHAM
Martz, Walter Scott, Jr.
Russell, Hewlett A.

HAMILTON—Stiles, Elisabeth

HOUSTON—Adams, John Emery
Addington, James William
Aderman, Charles Vidor
Adkins, W. S.
Adler, Joseph L.
Akkerman, Richard Pete
Albertson, Maurice M.
Allen, Charles Maurice
Allen, Harris Hayes
Allen, Stanley R.
Allison, A. P.
Anderson, John G.
Andrau, Evert Willem K.
Andrews, Wilton W.
Archie, Gustave Erdman
Armstrong, Earle N.
Bader, Glenn Ernest
Baker, William A., Jr.
Ballard, James L.
Bannahan, Annabelle R.
Banta, Henry Eugene
Barber, Clifford Fountain
Barragy, Edward J.
Barrow, Leonidas T.
Barry, John O'Keefe
Batla, Thomas Woodrow
Bauernschmidt, A. J., Jr.
Bayle, Pierre
Beckelhymer, Roy L.
Beckelhymer, Veronica Jennie
Beilharz, Carl F.
Bell, Olin G.
Belt, Ben C.
Belt, Walter Edwin, Jr.
Benish, Robert Lowell
Bennett, Edwin Oliver
Bennett, Malcolm Dorden, Jr.
Bennett, Roy Francis
Berg, Gilman A.
Berthiaume, Sheridan A.
Bertram, Alexander Carl
Bible, John Lowell
Black, Jo Pat
Blackstone, Thomas Warner
Blau, Ludwig Wilhelm
Bleyberg, Arnold
Blouin, Cecil Francis
Bolinger, John Wiley
Booth, Robert T.
Born, Howard Raymond
Bostick, Francis Xavier
Bowles, R. C.
Bowles, Thomas K.
Bowling, Leslie
Bowman, Wayne F.
Boyd, Lewis Henry
Boyles, James M.
Brace, Orval L.
Briard, Vernon E.
Bright, Anna Lou
Brill, Virgil August
Brinkerhoff, Ira A.
Brokaw, John M., Jr.
Brooks, James Andrew, Jr.
Broussard, Charles Hugh
Broussard, David Franklin
Broussard, E. Chester
Broussard, Lloyd J.
Broussard, Marion Ursin
Brouwer, Luitzen E. J.
Brown, Hart
Brown, Samuel B.
Bruyere, Alan
Bruyere, Richard Newbold
Buchanan, George S.
Buck, E. O.
Buckley, Stuart Edward
Bugbee, James McKean
Bunsen, Albert Washington
Burchfiel, Hugh Lee
Burkhead, Wayne Z.
Burton, Joseph M.
Byers, John William
Byron, Clifford Winkler
Calohan, William F.
Campbell, Curran Roland
Campbell, John Leslie P.
Campbell, William Robert
Cantrell, Ralph B.
Carey, Hillard W.
Carlton, Dave P.
Carpenter, Robert Gordon
Carr, George W.
Carsey, J. Ben
Carstens, Frederick D.
Carter, Charles William
Cartwright, Lon D., Jr.
Casey, Sam Russel, Jr.
Cashin, D'Arcy M.
Chambers, Robert Jack
Charrin, Paul
Childerhose, Allen J.
Childers, Aimer Floyd, Jr.
Chun, Harold August
Church, Charles R., Jr.
Clark, Clare M.
Clark, Frank T.
Clark, George Howard
Clark, Paul Henry
Clark, W. C.
Clark, William A., Jr.
Clement, George M.
Cogen, William Maurice
Colle, Jack Overton
Collett, J. Daviss
Conrad, Charles S.
Cook, Paul Chronical
Cooke, William Forester, Jr.
Cox, Harris J.
Crowell, John Head
Crume, Robert Wilbur
Cruse, John S., Jr.
Culbertson, John Archer
Curran, James Michael, Jr.
Dake, Laurence Falkenstern
Darling, Jack N.
Davis, Donald M.
Davis, Flavy Eugene
Davis, Morgan J.
Dawson, Lester Raymond, Jr.
Dawson, Robert John
Day, Willard L.
Decker, LaVerne
DeLancey, Charles J.
Denham, Richard Lane
Deussen, Alexander
Dicken, Russell H.
Dickson, Dorothy MacGregor
Dillon, Edward Cunningham
Dodd, James Grady
Doherty, Wilfred Thomas
Downey, Hugh P.
Drummond, C. Hanford
Dunlap, Albert D.
Durkee, Robert R.
Earl, Eugene Leonard
Eby, J. Brian
Eckart, Robert R., Jr.
Edson, Dwight J.
Elliott, Andrew C.
Ellis, Albert D., Jr.
Ellisor, Alva C.
Esgen, W. K.
Evans, Frank Garrettson
Fenn, Ivan J.
Ferguson, Hershal Cevera
Ferguson, Jack B.
Ferguson, Kenneth Howell
Ferguson, William Boyd
Fisher, Dunbar Allen
Flowers, Jackson Jefferson
Flude, John William
Fohs, F. Julius
Foster, Abner Lipscomb
Fox, James P.
Frank, Anne Moring Robins
Franklin, Louis
Franz, Leslie James
Fritts, Harold M.
Frost, Jay Miles, III
Fry, Earl E.
Fulghum, Henry Leroy
Fuqua, H. B.
Futral, John Edward
Gahagan, Donald I.
Gale, Arthur Sullivan, Jr.
Galloway, Alan James
Gardescu, Ionel I.
Gardner, Frank Johnson
Garrett, Julius Benjamin, Jr.
Geis, Harold Lorenz
Getzendaner, A. E.
Geyer, Richard A.
Gibson, Howard A.
Goldston, Walter L., Jr.
Goldstone, Frank
Gollnick, Robert Louis
Goodrich, Paul K.
Goodrich, Raymond H.
Gordon, Dugald

Gorman, William Albert
Granberry, Raymond Jame
Gravis, Leo Carroll
Gray, George Robert
Gray, Shapleigh G.
Gray, William D.
Griffin, Irving M., Jr.
Grosjean, Robert
Grossman, William Lewis
Guyod, Hubert
Hafner, W.
Hagen, Cecil Vernon
Halbouty, James Jubron
Halbouty, Michel Thomas
Hall, Thomas Ola
Halsted, Morris E.
Hamman, John, Jr.
Hamner, Edward John
Hancock, William T., Jr.
Hanna, Marcus A.
Hansard, Charles O., Jr.
Hansen, Malcolm B.
Harang, Jack Francis
Hardin, George C., Jr.
Harkins, Thurman L.
Harrington, George Haymond
Harrison, Robert Wright
Hartley, Burton
Hasselmann, Karl F.
Hedley, J. David
Heid, Gordon Witherspoon
Henninger, W. F.
Henquet, Roger
Herald, Elizabeth Anne
Herring, L. B.
Hervey, Oney Scyprett
Higgs, Morton T.
Hinson, Hillord
Hoard, J. O.
Hodder, Roland Frederick
Holbrook, Finley W.
Holcomb, Charles Wayne
Holland, Mary Loreen
Holland, Richard Marion, Jr.
Hornberger, Joseph, Jr.
Horvitz, Leo
Housh, C. N.
Hoyt, William V.
Hubbert, Marion King
Hunter, Paul B.
Hutchinson, Frederick M.
Igau, Hubert C.
Ikins, William Clyde
Irwin, Carl B.
Israelsky, Merle C.
Ivy, John Smith
Jackson, Ralph Semmes
James, Jay R.
James, Nelson H.
Jay, Stanley E.
Jennings, Philip H.
Jenny, W. P.
Jett, James Everett
Johnson, Charles Spurlin
Johnston, Harry Wilton, Jr.
Johnston, Lois Louise
Jones, Albert Lee
Jones, Harold E.
Jones, Park J.
Jones, Robert L.
Jones, Wayne V.
Judson, Sidney A.
Kelly, Pennell Clarke
Kemp, Harold S.
Kern, Jack Charles, Jr.
Kidd, Gentry
Kilian, Harry
King, Helen June
Kirby, Grady
Koch, Heinrich Louis
Konkel, Philip M.
Kovac, M. Stephen
Krause, Fred W.
Ladner, Albert Leo
Lake, Charles L.
Lake, James Ludwell, Jr.
Lang, Joseph Winford
Langford, Othell Franklin
Larke, Walter Joseph
Larson, Carl L., Jr.
LaRue, James E.
Lasky, Bernard H.
Law, John Melvin
Lawhorn, Oliver Thomas
Lay, Roy L.
Leavenworth, Paul B.
Leeds, David Jacob
Leonardon, E. G.
LeRoy, Tom E.
Lewis, James O.
Lewis, Ray C.
Lewis, Wendell L.
Lindsay, Sidney Afton
Loftis, John Landrum, Jr.
Lott, Alfred Walker
Lowman, Shepard W.
Lucky, M. C.
Lueth, Clinton A.
Lyons, Richard T.
Magalis, Cyrus West
Maginnis, Charles F.
Manes, Oscar Bob
Marr, John D.
Martin, B. G.
Martin, Jack
Martin, John Charles, Jr.
Martyn, Phillip F.
Marx, Archer H.
Mason, Shirley L.
Mathes, Donald E.
Mathieu, Jean Leon
McAdams, Ronald Earl
McCarter, W. Blair
McDonnold, Haydon W.
McFerron, George I.
McGee, John Evan
McGowan, F. H.
McGuirt, James H.
McLellan, Hiram J.
McReynolds, Gregg F.
Mettner, Francis Edwin
Meyers, Percy A.
Michaux, Frank W., Jr.
Miller, Buford
Miller, Forrest J.
Miller, Howard L.
Miller, John C.
Miller, Robert DuWayne
Mills, Ruben C., Jr.
Ming, Raymond E.
Minor, H. E.
Mitchell, Goerge Dampier, Jr.
Mitchell, Robert B.
Montgomery, James Campbell
Morgan, John Man
Morris, A. Ferd
Morris, Louis Henry
Morrison, T. E.
Morse, Roy R.
Mossom, Stuart
Mower, Lowell K.
Mueller, Frederick Walter
Murray, Irvin Bernard, Jr.
Myers, John C.
Nance, Albert G.
Neal, Richard Freeman
Nelson, Floyd A.
Nelson, Fred M.
Nelson, Raymond Thomas
Nettleton, L. L.
Neuman, Leonard J.
Newfarmer, Leo Ray
Nichols, Ivan K.
Nichols, Ralph Gregory
Noble, Homer A.
Noland, Orval W.
Nye, George Layne
O'Brien, Decatur
O'Donnell, Lawrence
Ogg, Thomas A.
Olcott, David Perry
Orynski, Leonard W.
Osterhoudt, Walter J.
Owen, Kenneth Dale
Park, Noel Robertson
Parker, William Gilmore
Parsons, Claude P.
Patrick, Walden W.
Pawley, Julian Kingsbury
Paxson, Roland B.
Peacock, Henry Bates
Percy, Charles Stuart
Petrick, Glen
Petrusek, Benjamin J.
Phillips, Henry H.
Pierce, Harold Frederick
Pollard, Jack C.
Pyeatt, Lloyd M.
Quigley, Claude Merle, Jr.
Raasch, Albert Charles, Jr.
Rabensburg, Aubrey Henry
Randolph, James Richardson
Ray, Robert Hillyer
Reasoner, Melton A.
Reed, Charles Merton
Reed, Edwin M.
Reed, Paul Carty
Reedy, Milton Frank, Jr.
Reiter, Wilhelm A.
Remick, David B.
Reynolds, Frank Fisher
Riddle, James Irvin, Jr.
Robertson, Parker A.
Robinson, Ernest Guy
Rolshausen, F. W.
Roper, Frank C.
Rosaire, E. E.
Rose, Nicholas Anthony
Rowe, Ural A.
Runion, Felix Anthony
Russell, C. A.
Rust, William Monroe, Jr.
Sample, Charles Hurst
Sappington, Chester
Sasse, Jerome B.
Sauls, James LeRoy, Jr.
Saville, Wilson Gordon
Sawtelle, George
Schaeffer, Hugh C.
Schafer, Sidney
Schempf, Foster John
Schnurr, Cornelius
Scholl, Louis A., Jr.
Schumacher, Jan P.
Scott, Erwin Ralph
Self, Selden R.
Selig, A. L.
Seren, Gordon Wilbur
Shearer, Louis Hollis
Sheets, Martin Meredith
Sherar, Edgar Smith
Sherar, Stuart
Shimek, E. Joe
Simmons, Benjamin T.
Sims, Samuel Eberle
Smiser, Jerome S.
Smith, Arthur E.
Smith, Aylwin Lorenzo
Smith, Edward James, Jr.
Smith, Erwin W.
Smith, Fred Lewis, Jr.
Smith, Gerald J.
Smith, Rex Milburn
Sollars, Perry Fredrick
Somers, George Brooks
Sorenson, Ira LeRoy
Spahr, Marshall Richard
Sparenberg, G. Russell
Speed, Carleton D., Jr.
Spoor, Harry C., Jr.
St. Germain, R. J.
Stangl, Frank J.
Stephenson, Elizabeth Earl
Stephenson, Morton B.
Stevens, George D.
Stewart, Charles H.
Stoddard, Gail Hyatt
Stone, George Bailey
Stratton, Everett Franklin
Stuckey, Charles W., Jr.
Swigart, T. E.
Symonds, Henry Gardiner
Taber, Edward Carroll, Jr.
Tamborello, Anthony Joseph
Tatum, Emmett P., Jr.
Taylor, Josiah
Taylor, Thomas Francis
Taylor, W. Harlan
Teague, James Udell
Teas, L. P.
Teten, Robert Paul
Thompson, Evan G.
Thompson, Wallace C.
Todd, John David
Todd, Oliver J.
Torrey, Paul D.
Travis, Maury Marion
Troxell, John N.
Tucker, Robert Louis
Tyson, Alfred K.
Uhrig, Leonard F.
Urbom, Oscar William
Van Burgh, Lisle R.
Van Eaton, Raymond Andrew
Van Melle, Francois Anthonie
Vaudoit, Paul L.
Vesely, Leon Robert
Vetter, John M.
Vogler, Edward Allen
Voigt, Harold E.
Von Eiff, Herbert Craft W.
Wallace, Davis M.
Walton, Britain Williams
Warner, Charles A.
Warren, Howard C.
Weaver, Paul
Welsh, LeRoy G.
Wendler, Arno Paul
Westmoreland, Frank Smith
Weymouth, A. Allen
White, Daniel Jefferson, Jr.
Wilhelm, Oscar G.
Williams, Charles Hiram
Williams, Herbert E.
Wilson, Arthur Noble
Wilson, Ernest Bradley
Wilson, Forest Wayne
Wilson, James Ernest, Jr.
Wilson, Ralph Woodrow
Wold, John Schiller
Wolf, Albert G.
Wolfram, Bertram, Jr.
Wood, Mary C.
Wood, Owen Bishop
Woods, Raymond Douglas
Yarborough, Hunter, Jr.
Zaba, Joseph
Zimmerman, Charles C.
Zirbel, Nicholas Newton

IRAAN—Browning, Chloe A.

JEFFERSON—Flesh, David James

KARNES CITY—Wolf, George H.

KENEDY—Ramsay, James Edwin

KILGORE—Caver, William Frank
Fouts, John M., Jr.

KINGSVILLE—Dismukes, James S.
Miller, William Rinehart
Muil, Charles William
Porter, Hugh, Jr.
Roberts, Charles V., Jr.

LAMESA—Forward, Frederick W.
Giles, Howard Windfield

LAREDO—Campbell, John M.

LIVINGSTON
Alexander, Walter H.

LOCKHART—Brown, Ira Otho

LONGVIEW—Bush, Robert Ewell

LUBBOCK
Daly, John Warlaumont
DeWoody, Ralph Cool
Elkins, Campbell Hill
Feather, Virgil G.
Johnson, Lester Hayden
Klaus, Hellmut

Latch, Leonard
Loomis, Harve
Patton, Leroy T.
Robinson, Wilbur Irving
Sidwell, Raymond

LULING—Woolsey, E. V.

MADISONVILLE
Musgrave, Albert W.

MARATHON
Maxwell, Ross Allen

MATAGORDO
Ritz, Clifford Harold

McALLEN—Arnold, Emmett L.
Bivens, Wilmer Edward, Jr.
Nichols, C. R.
Oliver, Richard R.
Robinson, Cecil D.
Smith, Lee Cherry
Stoneham, Sebron Lloyd
Ware, T. Preston
Warner, J. Laird

MEXIA—Liddle, Ralph A.

MIDLAND—Abell, George T.
Allen, William Hammond
Anderson, Kenneth Clyde
Anderson, Richard S.
Anderson, Warren D.
Arick, Millard B.
Armstrong, J. M.
Ashmore, Leland Wayne
Bailey, John James
Barnhart, Carl F.
Bartley, Jerald Howard
Beckmann, Harry LeRoy
Betts, Andrew John
Bingman, Neal J.
Bleakley, Alfred Bishop
Bradley, Henry Waring
Brown, Leslie Thomas
Brown, Prentice F.
Bucher, John Eric
Butcher, Cary P.
Canon, Joe
Cantrell, Cyrus Duncan, Jr.
Carter, George R.
Chambers, Ralph David
Chase, Carlos Louis
Clarke, Robert L.
Clarkson, William George, Jr.
Coil, Fay
Coldwell, Charles Hatton
Cole, Charles Taylor
Conkling, Russell C.
Conkling, William Henry
Coon, Maisie I.
Corey, George Simpson
Cottingham, Virgil E.
Covington, Jerry
Cox, Robert T.
Cox, William Edgerton
Crawford, Gayle P.
Crays, Glenn Edward
Dahl, Arnold C.
Dale, Dare Daniel
David, Max
Davis, Howard Eugene, Jr.
DeFord, John Hill
DeFord, Ronald K.
Dickey, Robert I.
Diemer, Raymond Adams
Donnelly, Alden Stuart
Dougherty, William Edgeworth
Douglass, Francis A., Jr.
Doyle, Robert
Dressel, Waldemar M.
Durham, Charles Albert
Dykstra, Bouwe
Ellison, Samuel P., Jr.
Ferrell, Jane
Fillman, Louise
Firstenberger, John Graeme
Fitting, Ralph U.
FitzGerald, James, Jr.
Forgeron, Harold S.
Fritz, William Clayton
Gibson, George Randall
Giesey, S. C.
Gile, Richard E.
Green, Charles Campbell, Jr.
Grice, Charles Richmond
Griswold, Edward Harvey
Haigh, Berte R.
Harbison, Robert Ranney
Hardison, Harvey
Harper, Oliver C.
Hartwell, Moreland T.
Hatch, Jesse Duff, Jr.
Hedrick, O. F.
Hemphill, Herbert A.
Henderson, Charles Frederick
Henderson, William David
Herd, John Harvey
Hilburn, Sam E.
Hills, John Moore
Hilseweck, William Joseph
Hirsch, Nolan
Hitchcock, Edmund Stewart
Holland, Dan E.
Holland, Dorothy Sinex
Hollingsworth, Richard V.
Huffman, Harold LaVergn
Hyde, Ben Cooper
Imbt, Robert F.
Imbt, William C.
Ireland, Hubert Andrew
Irwin, Wallace W.
Johnson, Jane Marie
Jones, Crandall Davis
Jones, Theodore S.
Jorgensen, Jay A.
Kellett, Louis B.
Kimberlin, John Zay
Koenig, Joseph Baldwin
Kolm, Paul H.
Kotyza, Fred Frank
Kribbs, George R.
Larsh, Napoleon Bonaparte
Larson, Philip D.
LeBlond, Robert Edmond
Leeper, Alan Bertrand
Lillibridge, Frederick S.
Lindeblad, E. E.
Lindeblad, Ludvig C.
Lloyd, E. Russell
Loskamp, Alvin P.
Lyle, William Eugene, Jr.
Maley, Vaughn C.
Mauck, Melvin Dwight
Mayfield, Gid Calmese
McClure, Joseph Hugh
McCullough, Edward Allen
McFall, Rex Lewis
McGuigan, Francis Henry
McKinsey, Mark Howard
McLennan, Lamar, Jr.
Metz, Milam Sutton
Michaelson, Louis Henry
Miller, Harry August, Jr.
Miller, Milward
Mills, Lloyd Clarence
Minton, Morris Creswell
Monahan, Foster Murray
Moore, Joe Laurence
Moore, John I.
Moore, Lee Wayne
Moore, Prentiss D.
Morgan, Robert Edward
Morningstar, Clyde Franklin
Mygdal, Karl A.
Oliver, Donald McCreery
Osborn, William Macklin
Park, Lee Brown
Parker, Thomas Reilly
Parsons, Kenneth Robert
Penn, William Y.
Pennel, Harry David
Peters, Lavon Marie
Peterson, Victor Edwin
Pettit, Albert Edwin
Price, James A.
Putnam, George D.
Rankin, Robert Estes
Ray, Bernerd Arthur
Repecka, Albert Lee
Rhodes, Mary Louise
Rogers, Jesse Armstead
Rogers, Victor William
Ruwwe, John W.
Ryan, Thomas Patrick
Schneider, William Thomas
Schwade, Irving T.
Scobey, Ellis Hurlbut
Scobey, Warren Barrett
Scrogin, John Mills
Secor, Dana M.
Senning, Robert Conrad
Shaeffer, Stanley Beaubien
Shaw, Charles Anderson
Skinner, John Wesley
Sklar, Maurice
Smith, Holly E.
Spivey, Robert Charles
St. Clair, Donald W.
Stall, Trovall Lafayette
Steig, Maynard H.
Steinberger, Clark R.
Stoltenberg, Harold Waite
Symes, Clarence, Jr.
Tanner, Hugh A.
Tennant, Robert Hudson
Terrill, John Vincent
Thomas, Leonard C.
Thomas, William A.
Tompkins, Joseph D.
Turner, Clyde Weldon
Vanderpool, Eugene Ward
Veeder, John A.
Vertrees, Charles D.
Von Osinski, William Philip C.
Waldschmidt, W. A.
Walne, Walter Hillman, Jr.
Warren, John Edwin
Watson, Robert N.
West, William Ward
White, Gordon H.
Wilgus, Wallace LaFetra
Williams, Harold L.
Williams, Meryl Dedrick
Winkler, Hans
Winter, Niles B.
Woods, E. Hazen
Woolley, William Leeman
Wright, Fred S.
Young, Addison
Young, Claude T.

NEWGULF—Judson, Wilbur

NOCONA—Martin, P. M.

ODESSA—Cast, Richard Frederick
Patterson, Luther Edwin, Jr.
Pederson, Clyde Marion
Samuell, J. Howard
Sellon, C. Wayne

OLNEY—Craig, William Henry
Hayes, Reese L.
Whitcomb, Bruce

ORANGE—Hakes, Willard Renick

OZONA—Robert, Price E.

PALACIOS—Sisson, Harry Hensel

PALESTINE—Williams, Richard

PAMPA
Anderson, Benjamin Louis
Gallie, John Francis
McConnell, William Hall
Sanford, Wendell Glenn
Schwartz, Harold Edward

PERRYTON—Bell, Clifton L.

PLEASANTON
Williams, Carroll L.

RIVERSIDE—Weinzierl, John F.

ROBSTOWN—Bryan, B. F.

ROSENBERG
Ustynik, Edwin Frank

SAN ANGELO—Cannon, Joe
Cannon, R. L.
Dodson, Floyd C.
Emch, John W.
Gregory, Joseph Nalle
Hagan, Arthur M.
Morgan, George D.
Ott, Emil
Ray, Wilbur Clyde
Shock, Lorenz Ira
Simpson, Roscoe M.

SAN ANTONIO
Absher, Kenneth B.
Achning, Walter J.
Alcorn, Avary Hunt
Bakke, W. E.
Banks, Thomas R.
Barbisch, Joseph William
Bazhaw, Willis Oliver
Becwar, Harold David
Begeman, Robert Louis
Benedum, Darwin
Best, J. Boyd
Bonar, Robert Emerson
Boyer, Will W.
Boyle, Walter J.
Brown, Gilbert LeRoy
Buskirk, Gordon Towers
Camp, John F., Jr.
Cannan, Morris
Cardwell, D. Harold
Chapell, Donald Owen
Closuit, Ernest M.
Coates, George H.
Colton, Howard Franklin
Cooper, Herschel H.
Corning, Leavitt, Jr.
Crawford, Weldon L.
Davis, Field M.
Davis, Thornton
Dawson, Herbert Marion
Dickinson, Clyde Grant
Douglas, L. A.
Dovre, Adolph
Doyle, John Finley, Jr.
Durward, Robert Harland
Elms, Morris Allen
Evans, Ralph
Eyssell, Alfred Raah
Ferrando, Aldo
Fish, Leroy
Forney, Maurice Edgar
Foster, Fred K.
Gandy, Thomas Stephens
Goodman, Herbert Maynard
Green, Guy E.
Gross, Arthur B.
Gruner, Thayer Meredith
Gutke, Ralph Lewis
Haase, Fred M.
Hammond, Weldon W.
Haring, Louis Howard, Jr.
Harrell, Marshall A.
Harrison, John W.
Hemmi, Carl Wilburn
Henderson, H. H.
Hensch, Carl Russell
Herndon, Harold D.
Hinyard, Paul Brown
Hopf, Robert William
Howeth, Irving K.
Hunzicker, Vernon Jacob
Johnson, Edward Lee
Johnston, James Kendall
Kallina, Frank Cyril
Kearny, Clinton Charles
Kelley, Ward W.
Kelly, John Schlagle
Keppler, Leo G.
Kolm, Robert N.
Lawton, Joe
Liddell, Jessie Kelsey
Madden, Lloyd Willis
Mann, Robert Scott
Manthos, Atlee G.
Masterson, Reba B.
Matson, Martin
McCann, Joyce Irene Waters
McDonald, Worth W.
Mebane, Robert Duff
Menger, Hubert Emil
Monsour, Emil

Moore, Marion Jefferson
Morey, Philip Stockton
Myers, Julian Q.
Narvarte, Peter Eugene
Nelson, James C.
Nicholls, William Marvin
Nowotny, Wilbur A.
O'Brien, Joseph Alfred
Owen, Edgar Wesley
Palmer, Leland L.
Petty, Dabney E.
Petty, Olive Scott
Petty, Van A., Jr.
Picklesimer, Harold G.
Porch, Edwin L., Jr.
Potter, Grover C.
Rathbun, Keith L.
Ratliff, Guy Marvin
Renick, B. Coleman
Rife, Byron
Roberts, Gerald C.
Rogers, James K.
Roig, Chester A., Jr.
Ross, John C.
Row, Charles H.
Rowden, Dale Henry
Rudolph, Paul Jackson
Sandidge, John R.
Sandifer, Donald Ford
Schmidt, Karl Henry
Schoolfield, R. F.
Scott, Arvin Forrest
Scrafford, John Bruce
Seeligson, Arthur A., Jr.
Semmes, Douglas R.
Shaw, Silas Frederick
Sheldon, Mary Elizabeth
Shelton, George H.
Sloss, James Parker
Smith, George Wendell
Snow, Arthur Leland
Spencer, Richard Nelson
Spice, William H., Jr.
Stapp, Wilford Lee
Stewart, Charles A.
Storm, Willis
Swiger, Rual B.
Teagle, John
Teel, Dick
Tobin, Don Freeman
Tucker, Regan
Wagener, Charles H.
Warner, Ralph E.
Weatherston, Douglas
Webb, Sam Nail
West, Lloyd G.
West, Thomas Scott
Whitaker, Harvey
Whitsitt, Charles Dalton
Wiegand, Frederic William
Wiringa, Leon Otis
Wofford, Henry Rollins, Jr.
Woolley, Glen C.

SAN BENITO—Dunbar, Robert O.
Parker, Lloyd S.
SEMINOLE—Wise, Henry Francis
SEYMOUR—Kemp, Augusta H.
SHERMAN
Borland, Allen Milton
Bowen, Gilbert Todd
SINTON—Corman, Hyman
Fipps, E. L.
Jennings, Charles I.
LaRue, Wilton W.
Yoakam, Harlan Hunter
SUDAN—Perrin, Francis Ward
SWEETWATER
Johnson, Elton DeLoss
Montgomery, Porter A., Jr.
TAYLOR—Grimes, Russell W.
THREE RIVERS
Dexter, Laurence N.
TYLER—Adams, Frank C.
Alexander, C. I.
Bell, John Smith
Bierman, Alfred C.
Blanchard, Stanley W.
Bradford, Charles Edward
Branson, Delmar O.
Brock, Stephen W., Jr.
Bunn, John R.
Burford, Selwyn O.
Burling, Robert
Burnett, T. J.
Burton, George E.
Campbell, Thomas Brown
Cartwright, Weldon Emerson
Cash, Thornton C.
Clark, G. Conrad
Dana, Edward B.
Eaton, Robert Wesley
Ely, George Norman
Floyd-Jones, Jane
Fox, Hamlin Garland
Gibson, Donald Thomas
Gilles, Lawrence A.
Hood, Forrest W.
Howard, Edward Lain
Hudnall, James S.
Lees, Laurence F.
Lester, Howard H.
Loetterle, Gerald John
Long, Walter Edwards
Lozo, Francis Edgar, Jr.
Matheny, H. Claire
McFadden, William A., Jr.
Melzer, Laurence S.
Mix, Charles A.
Moore, Barton Walker
Murphy, Boyd Ferguson
Oliver, Garnet William
Pirtle, George W.
Potter, Harold Eugene
Richardson, William Eastburn
Samford, Finis Mack
Schoeneck, Philip S.
Shelby, Thomas H., Jr.
Tefft, Gerald Homer
Trowbridge, Raymond M.
Weaver, George A.
Wendlandt, Edward A.
Wilson, Edward B.
Wright, Andrew Clemmons
Youngmeyer, Ray

VICTORIA—Fly, Paul J.
WATER VALLEY—Kinkel, W. C.
WEATHERFORD
Smith, John Peter
WESLACO—Christner, Harold R.
WICHITA FALLS
Adams, Robert J.
Ammon, Walter Lamm
Birk, Ralph Adolphus
Bitgood, Ellen Posey
Bowen, James P.
Cunningham, Carleton J.
Daniel, Orion A.
Davis, Ethel Margaret
Davis, John Roland
Davis, Lon, Jr.
Dennis, Lyman Clark
Dilger, Raymond Joseph
Dimock, George Wagner
Dorbandt, Leslie Winston
Drake, Robert Tucker
Edwards, Acus Rex
Edwards, Harold S.
Fosdick, Arthur R.
Fowler, William James
Franklin, Donald Wilbert
Gibbs, James F.
Giddings, Harvard
Gram, Oscar Ebsen
Gray, Donald Arthur
Guinn, Delmar R.
Hanson, Hal Craig
Harden, Lynn L.
Hardison, George Porter
Haseltine, William Lloyd
Hauptman, Herman Ray, Jr.
Heninger, Dan D.
Ise, Charles Henry
Kay, John A.
Kelly, Donald
Lang, William J.
Langford, David Kemp
Linehan, Charles M.
Lucke, Lester A.
Mankin, Warren Ward
Maucini, Joseph J.
Mayfield, William Isaac
McAdams, James Lush
McGaha, Charles P.
McKinlay, Ralph Harold
McLaren, Robert L.
McMahon, Beverly Edith
Mohler, Donald Phillips
Moorhead, Johnny Bob
Mort, Frank Paulsen
Mosher, William Nelson
Mowrer, Loren E.
Nicola, Oliver Peter, Jr.
Owens, John Edward
Pettigrew, Virgil
Petty, T. F.
Phillips, Richard Beach
Purcell, Paul E. M.
Quigley, James Alonzo
Reed, Edward Looman, Jr.
Richards, David Taylor
Rickard, Hilton Lloyd
Roth, Robert
Russell, J. J., Jr.
Ryan, Jack Burnside
Ryan, Reginald G.
Scholl, Guy J.
Schweer, Henry Fred
Seitz, J. R.
Simic, Dolphe E.
Smiley, H. F.
Snebold, William F.
Stilley, Earl M.
Wadsack, George E., Jr.
Waggoner, Stephen Gose
Wengerd, Sherman Alexander
White, Albert William
Wolverton, Harold A.
Wood, Clint B.

UTAH

ESCALANTE
Kinser, James Hanford
GREENRIVER—Allen, Charles F.
LOGAN—Williams, J. Stewart
OGDEN—Adair, J. Smith
PROVO—Hansen, George Henry
SALT LAKE CITY
Bowen, Charles F.
Gaul, George Howard
Hauptman, Charles A.
Hunt, Charles B.
Minton, Robert Joseph
Needham, Claude E.
Whittier, William H.
VERNAL—Fields, Harry B.
Williams, Philip A.

VIRGINIA

CHARLOTTESVILLE
Cederstrom, Dagfin John
McGill, William M.
LEXINGTON
Stow, Marcellus H.
NORFOLK
McLean, James D., Jr.
RICHMOND—Spangler, Walter B.

WASHINGTON

COULEE DAM—Goldsmith, Leo J.
ELMA—Lupher, R. L.
OAK HARBOR
Johnson, Russell V.
OLYMPIA—Billman, Harold G.
Chawner, William Donald
Glover, Sheldon L.
Stanton, W. Layton, Jr.
PULLMAN—Culver, Harold E.
SEATTLE
Barksdale, Julian D.
Hunt, Leo Frank
Knox, John K.
Mitchell, Harold DeLong
Monahan, Charles Joseph
Weaver, Charles E.
Willis, Clifford L.
SPOKANE
Kirkham, Virgil R. D.

WEST VIRGINIA

CHARLESTON
Anderson, Ray Ball
Barney, Arthur Y.
Billingsley, J. E.
Lafferty, Robert C., Jr.
Maxwell, William Byron
McClain, Alan H.
Simmons, Harvey J., Jr.
Stanton, Edward Cramon, Jr.
Ziebold, William O.
CLARKSBURG
Mayfield, William W.
Tollefson, Everett Harold
HUNTINGTON
Miller, William C.
LEWISBURG
Argabrite, William G.
MORGANTOWN
Alkire, Robert Leo
Galpin, Sidney L.
Martens, James H. C.
Price, Paul Holland
Reger, David B.
Tucker, Rietz Courtney
PARKERSBURG
Rogers, Reginald D.

WISCONSIN

BELOIT—Croneis, Carey
COLUMBUS
Brossard, Eugene E.
MADISON
Crump, Ruth Mary Dudley
Feray, Dan Edwards
Gilbert, Edward Everett
Thompson, Marcus Luther
Young, Keith P.
MAYVILLE—Buchner, Carl F.
MILWAUKEE
Greacen, Katherine F.
RACINE—Kummel, Bernhard, Jr.
WEST ALLIS
Mestier, Arthur J., Jr.

WYOMING

CASPER
Allardyce, Robert E. L.
Baptist, Oren Cecil
Barkell, Clifford Abbott
Barrett, Albert F.
Boos, Edward J.
Chorney, Raymond
Clark, Alexander
Cox, Thomas S.
Crawford, James Gilmore
Curry, H. Donald
Curry, William H., Jr.
Dady, William George
Edstrom, Donald Edwin
Enders, Dean W.
Fanshawe, John Richardson
Fenwick, Willis Henry
Ferguson, Robert Dewitt
Goodin, George Lewis
Hall, W. E.
Hiestand, Thomas C.
Hoenshell, David T.
Horn, George H.
Hubley, Myron D.
Iglehart, Charles Fayette
Kelley, Frederic Richard
Kirby, Thomas L.
Knouse, William Stanley
Krampert, E. W.

Larsen, Raymond M.
Maebius, Jed B.
McCabe, William Stokes
McCanne, Rolland W.
Mercer, Leonard Arthur
Miller, John Robson
Mitchell, Robert Oliphant
Netterstrom, Paul W.
Olson, Waynard George
O'Rourke, Sinon Philip
Paddleford, Jack Teal
Potter, Nelson B.
Pye, Willard D.
Rea, Henry Carter
Reinhart, Philip W.
Robbins, Raymond Willis
Roberts, Thomas N.
Schwabrow, John R.
Sielaff, Robert L.
Siemon, Paul
Souder, Warren James
Spalding, Robert W.
Sternberg, Charles William
Summerford, H. Edgar
Surber, Nathan Courtney
Tallant, Roy L.
Thomsen, Harry L.
Tixier, Maurice Pierre
Van Gilder, H. R.
Walton, Paul Talmage
Winfrey, Donald B.

CENTENIAL
Morgan, Frank Albert, Jr.

CODY—Gilbert, James Cornelius

EVANSTON—Bradbury, Albert E.
Landon, Robert Emmanuel
Vrang, Christian M.

KAMMERER
Schombel, Leonard F.

LANDER—Downs, George Reed
McCoy, Joseph H.
Rogers, Wilbur Frank
Sharkey, Henry Howe Robbins
Soderberg, Carney Ray

LARAMIE—Beckwith, Radcliffe H.
Blackstone, Donald LeRoy, Jr.
Espach, Ralph Homeward
Jacobsen, Clyone Lynn
Krueger, Max L.
Love, John David
Thomas, Horace D.
Thompson, Raymond M.
Tourtelot, Harry Allison

LUSK—Stafford, Clare J.

RAWLINS
Hart, Lawrence Theodore
Kyle, Jerry Robert
McCulloch, James Cole
Nance, James Weldon

RIVERTON—Matthews, Edwin P.

ROCK SPRINGS
Fidlar, Marion M.
Gras, Victor Brooks
Kivi, Wilho John
Nightingale, W. T.
Skeeters, Warren Ware

SHERIDAN
Gorton, Kenneth Arnold
Mullinax, Jack D.

TEN SLEEP—Parks, Emerson M.

THERMOPOLIS
Milek, William A.

ALASKA

FAIRBANKS—Folk, Stewart H.

ALBERTA

CALGARY—Armstrong, John A.
Beach, Hugh Hamilton
Chilton, James Ryder
Clark, Leslie M.
Cook, Ian MacLaren
Corbett, Clifton S.
Erdman, Oscar Alvin
Farmilo, Alfred William
Falconer, Wilbert Lawrence
Galloway, John O.
Gleddie, Joseph
Gray, John Gardiner
Hage, Conrad O.
Hamilton, Robert John
Hancock, Willis Pritchard
Hoover, Malvern Edward
Howells, William Crompton
Hunt, Edwin H.
Hunter, Harry M.
Irwin, J. S.
Junger, Arne
Keevil, Alan Richard
Killer, Frederick Anderson
La Berge, A. Lionel
Layer, Douglas Bruce
Lines, Frederic G.
Lockwood, Robinson P.
Mackenzie, Andrew N.
McGehee, J. Rex
McKinnon, Frederick Allan
Nichols, Norval W.
Perry, Bernard James
Reidford, Harry Kenneth
Sanderson, James O. G.
Scott, James Campbell
Shaw, Ernest William
Slipper, S. E.
Spratt, Joseph G.
Storm, Lynn W.
Walters, Ray A.
Willson, John Norman

EDMONTON
Allan, John Andrew
Beard, Gordon Currie
Crockford, Michael Bertram B.
Rutherford, Ralph Leslie
Stoneman, Harold Wright
Warren, Percival Sidney

PRINCESS
Fulmer, Edward Andrew M.

PROVOST—Kerr, Samuel Aubrey

TURNER VALLEY—Gallup, W. B.

ANGOLA

LUANDA—Roschen, Ernest C. H.

ARABIA

DHAHRAN
Collins, Philson Delp, Jr.

ARGENTINA

BUENOS AIRES
Bracaccini, Osvaldo I.
Cook, Carroll E.
Ducloux, Abel Herrero
Martin, Rodolfo
Rozlosnik, Andres
Tarragona, Jose
Zunino, Juan Jose

CHUBUT—Dickinson, George

LA PLATA
Fossa-Mancini, Enrico
Suero, Tomas

MENDOZA—Feruglio, Edigio S.

PLAZA HUINCUL
Torrea, Aniceto Horacio

SAN JUAN—Leidhold, Clemens

AUSTRALIA

BRISBANE—Morgan, D. E.
Richards, Henry Caselli
Wade, Arthur

CANBERRA—Raggatt, Harold G.

GORDON—Woolnough, Walter G.

MELBOURNE—Gray, Kenneth W.
Greenham, Roy Leonard
Rudd, Eric A.
Stanley, G. A. V.

PERTH—Moss, Frank A.

TOWNSVILLE
Mott, William Dick

BAHAMAS

NASSAU—Cole, John Gordon
Heggblom, J. Conrad
Spencer, Maria

BARBADOS

BRIDGETOWN—Senn, Alfred

BELGIAN CONGO

COSTERMANSVILLE
Touwaide, Marcel E.

BOLIVIA

LA PAZ—Munoz-Reyes, Jorge

BRAZIL

BAHIA—Brazil, James Joseph
Keller, P. Hastings

BELEM—Mann, Neil Warren

MANAUS—Folsom, Tom E.

RIO DE JANEIRO
Abreu, Sylvio Froes
Denning, Wayne H.
Ritter, Ernest A.

SALVADOR—Pack, Oran L.
Riggins, Leslie Burnham, Jr.

SAO PAULO—de Lima, Plinio

BRITISH COLUMBIA

NEW WESTMINSTER
Johnston, John Russell

PAVILLION
Sterrett, Douglas B.

VANCOUVER
Back, Denys Howard

VICTORIA
Newmarch, Charles Bell
Williams, Thomas B.

BRITISH GUIANA

GEORGETOWN
Guimond, Stanislas de Kostka

CHILE

PUNTA ARENAS
Kniker, Hedwig T.
Mohr, C. L.
Simian-G., Eduardo

SANTIAGO
Grossling-F., Bernardo
Wenzel, Osvaldo Grube

CHINA

TIENTSIN—Juan, Vei Chow

COLOMBIA

BARRANCA BERMEJA
Denton, William Ernest

BARRANQUILLA
Ayers, Floyd M.
Lee, Herbert V.
Marti, Ernest John
Rigg, Robert Mader

BOGOTA
Acosta-Sarmiento, Gonzalo
Aitken, William Ernest
Alberding, Herbert
Alvarado, Benjamin
Barrett, John Frederick
Barrow, Geoffrey
Bickel, Harold Clayton
Bower, John O.
Bradish, Beverly B.
Brineman, John H.
Browning, John Mackintosh
Caudri, Cornelie Marguerite B.
Chappell, Walter M.
Colley, Bernard B.
Coote, George Frederick
Dohm, Christian F.
Elliott, Douglas Howard
Escallon, Marion Roberta de
Fonville, Herman Albert
Garwood, Roland William
Graves, Allan Dexter
Guerrero, Albert Lobo
Haanstra, Ulco
Hatfield, Willis Charles
Hazen, George Herbert
Howard, Jesse James
Joy, Oliver T.
Lee, Clarence L.
Lloyd, Joel Joseph
Lytel, Harvey M.
Marble, Kennedy R.
Marin, Roald Andre
Mazurczak, Ludwig
Merritt, Roy W.
Miley, Roy Allen
Miller, John Bakken
Morales, Luis German
Morgan, Ray Earland
Mulholland, Malcolm M.
Nelson, Donald Oliver
Newbill, Thomas Jefferson, Jr.
Nygren, Walter Eric
O'Gara, William Thomas
Oppenheim, Victor E.
Ospina-Racines, Eduardo
Perko, Albert Richard
Redmond, Charles David
Roach, Cyril Bloomfield
Sarmiento-Soto, Roberto
Saville, Charles William
Schroeder, Jean William
Sheldon, Robert Arnold
Silva, Will
Smith, Homer James
Smith, James Archibald
Stevenson, Frank Vincent
Tong, James A.
Trumpy, Daniel
Young, W. Ford

BOLIVAR
Murchison, Roderick G.

CARTEGENA
Bennison, Allan Parnell

CUCUTA—Bowler, James William
Schoonover, Jack Gardner

EL CENTRO—Waring, Waldo W.

MEDELLIN
Botero-Arango, Gerardo

CUBA

HAVANA
Bermudez, Pedro Joaquin
Daviess, Steven Norman
Gwinn, James William
Kirk, Howard M.
Palmer, Robert H.
Schaub, Hans Peter
Tucker, Paul M.

DENMARK

CHARLOTTENLUND
Odum, Hilmar

COPENHAGEN—Flagler, C. W.
Gregersen, Albert Ingstrup

VIBORG—McKee, Alexander H.

DOMINICAN REPUBLIC

TRUJILLO CITY
Lewis, J. Whitney

ECUADOR

AMBATO—Pierce, Guy Russell

GUAYAQUIL
Acheson, Cyrus Harold
Smith, Lorne Alexander
Williams, M. Dean

QUITO—Baker, Ronald Isaac
Walpole, Leonard Whitworth

EGYPT

CAIRO—Barker, Maurice H. S.
Chata, Abdou Ali
Eicher, Donald B.
Gaenslen, George
Greant, George Camille Felix
Gubbins, Richard Eldred
Iskander, Fawzi
Lucie-Smith, Geoffrey Ross
Millward, Louis George

Seager, Oramel Ainsworth
White, James Gordon
Zimerman, Sam

ENGLAND

BRIGHTON
Mendelsohn, Clive A.
BROMLEY—Lepper, G. W.
EAST RETFORD
Lovely, Herbert Richard
EXMOUTH
Waite, Stephen Temple
LONDON—Grimsdale, Thomas F.
Illing, Vincent Charles
Lees, George M.
Leyds, Louis W.
MacKay, Charles
Pyron, Gertrude Drach
MAIDENHEAD
Scott, Edwin Cooper
TEDDINGTON
Hutchison, Arthur Gilbertson
WESTMINSTER
Templeton, James C.

ETHIOPIA

ADDIS ABABA—Lock, John Henry

FRANCE

PARIS—de Cizancourt, Henry
Lynton, Edward D.
Migaux, Leon
Schlumberger, Marcel E. H.

GERMANY

BERLIN—Stille, Hans

GOLD COAST

TARKWA
Brown, James Chapman

HAITI

PORT-AU-PRINCE
Postle, Gordon Leo

HONDURAS

SAN PEDRO—Souther, John B.
TEGUCIGALPA—Beall, Robert

INDIA

KARACHI
Riddell, Charles Edwin

IRAQ

KIRKUK—Daniel, Edgar James
Henson, F. R. S.
McGinty, James

ITALY

FORNOVA TARO
Wiedenmayer, Carl

JAVA

BATAVIA—Hopper, Richard H.

MEXICO

CIUDAD CAMARGO
Yzaguirre, Lauro Antonio
MEXICO CITY
Alvarez, Manuel, Jr.
Arellano, A. R. V.
Burbridge, Charles E., Jr.
Garfias, Valentine R.
Kane, William G.
Ordonez, Ezequiel
Thomas, James W.
MONTERREY
Martinez, Fidel C.
Perez-F., Raul
OJINAGA—Still, J. T.
TAMPICO
Alba y Soto, Alonso de
van Rossum, Otto
Vazquez, Andres Lopez

NETHERLANDS

THE HAGUE
Baggelaar, Hermanus
Bard, Richards J.
Heater, W. E.
Hemmings, H.
Kundig, Ernst
Schurmann, H. M. E.
Taverne, N. J. M.
van Gogh, F. A. A.
van Weelden, A.
WAGENINGEN—Doeglas, D. J.

NEW BRUNSWICK

FREDERICTON
Wright, William Josiah
MONCTON—Hole, Herbert Wray

NEW CALEDONIA

NOUMEA—Pomeyrol, Rene

NEW ZEALAND

AUCKLAND—Bossard, Leon
WELLINGTON
Collins, Burton W.
Ongley, Montague

NIGERIA

LAGOS—Burr, Ian Laurence

NOVA SCOTIA

ANTIGONISH
MacNeil, Donald J.

ONTARIO

OTTAWA
Burling, Lancaster D.
Gussow, William Carruthers
Hume, George S.
TORONTO—Beck, August F.
Fournier, Frank Lawrence
Godefroy, Constant
Hopkins, Oliver B.
Link, Theodore A.
Mackenzie, William Donald C.
Tovell, Walter Massey
Roliff, William Albert
Springer, George Douglas
Sproule, John Campbell
Wheeler, Orby Clinton

PALESTINE

HAIFA—Browne, Richard Vernon
Damesin, Leopold Constant F.
Gibson, Francis Alex
Nasr, Sami N.
Wetzel, Rene Jacques
Williamson, Thomas F.
JERUSALEM
Wellings, Frank E.

PANAMA

DIABLO HEIGHTS
Moran, Thomas G.
Thompson, Thomas F.
PANAMA CITY
Hasbrouck, Bernard Romaine

PARAGUAY

ASUNCION—Cassel, Chester

PERSIAN GULF

BAHREIN ISLAND
Barger, Thomas C.
Bramkamp, Richard Allen
Kerr, Richard C.
Langham, Noel Thomas
QATAR—Hotchkiss, Henry

PERU

LIMA—Beatty, Robert M.
Fyfe, Douglas
Gallagher, John Patrick
Huff, Keith Frederick
Kreidler, William Lynn
MacGregor, James Donald
McGill, Andrew K.
Moore, Edward Lionel
Nauss, Arthur William
Parsons, Harold Ewing
Pflucker-C., Eduardo
Sumner, Walton
Sundt, Olaf Francis
Wallis, William E.
NEGRITOS—Bell, A. Lyndon
Bird, Stuart Frederick
Camminati-Cortes, Luis
Dorreen, James Moore
Stone, Benton
TALARA
Stainforth, Robert Masterman

PHILIPPINE ISLANDS

LUCENA
Daleon, Benjamin Angel
MANILA
Aycardo, Man Mathew, Jr.
Newman, George Hawkins

POLAND

KRAKOW—Bohdanowicz, Charles

QUEBEC

QUEBEC CITY—Jones, I. W.
WESTMOUNT
Wonfor, John Stephen

ROUMANIA

BUCHAREST—Hegwein, Walter H.
PLOESTI-TELEAJEN
Hlauschek, Hans

SASKATCHEWAN

SASKATOON
Edmunds, Frederic H.
Weir, James Donald

SPAIN

MADRID—Bray, Vinton Arthur

SWITZERLAND

BASEL—Tschopp, Herman I.
Vonderschmitt, Louis
BUCHILLON—Lehner, Ernest J.
GENEVA—Poldini, Edward Maria
LAUSANNE—Gagnebin, Elie A.
ZOLLIKON
Goldschmid, Karl Theodor

SYRIA

BEYROUTH—Birembaut, Arthur

TASMANIA

HOBART—Carey, S. Warren

TRINIDAD

PALO SECO—Baxter, George W.
Wilson, Cedric Clark
POINTE-A-PIERRE
Barr, Kenneth William
Bower, Thomas Henry
Higgins, George Esmond
Kugler, Hans G.
Rohr, Karl
Suter, Hans H.
Thomas, Hallowell Charles H.
Young, Raymond Owen
SAN FERNANDO
Boutakoff, Nicholas
Penny, Frederick W.

TURKEY

ANKARA—Bediz, Pertev I.
Lokman, Kemal
Ortynski, Hilary Igor
Tasman, Cevat E.
Tasman, Mehlika Izgi

URUGUAY

MONTEVIDEO
Vercesi, Daniel Rey

VENEZUELA

BARCELONA
Dawson, George W.
Krumholz, Alcuin John
Monaghan, Richard Joseph
Probst, David Arthur
Sass, Louis Carl
CARACAS
Aguerrevere, Santiago E.
Anisgard, Harry William
Bailly, Florent Houlding
Baird, Chester A.
Barclay, Stewart
Bond, Henry Lofland
Boylan, Ebert E.
Breitenstein, Robert S.
Butler, John Weston, Jr.
Caan, Albert Joseph Z.
Cody, Marian Coffman
Conrad, Peter Paul
Crebbs, Chester M.
Crickmay, Geoffrey William
Cullison, James S.
Dallmus, Karl F.
de Juana, Clemente Gonzalez
Deming, Joseph Horace
Desjardins, Louis Hosea
De Sola, Oswaldo
Dodge, John F.
Dodson, Louita Garner
Doell, Edward Charles
Dozy, Jean Jacques
Fenichell, Melvin Medford
Fichter, Hans Jakob K.
Floyd, Florin W.
Fowler, Charles W., Jr.
Freie, A. J.
Fricke, Kenneth Stewart
Funkhouser, Harold John
Geyer, Robert Lee
Gorman, Joseph Michael
Gravell, Donald W.
Guillaumin, Jacques, Jr.
Haight, Harold W.
Hale, Francis Ayers
Hamilton, Clarence Edgar
Henry, Leonard W.
Henry, Schuyler B.
Hill, Robert Grant
Horton, Jack Ogilvie
Hottinger, Arthur Felix
Hulsewe, Gerard Jan
Judson, Jack Finlay
Kaye, M. Kamen
Kehrer, Louis
Klecker, John Benedict
Knight, Oliver B.
Krum, William M.
LeRoy, Frank Leon
Lockett, George L.
Marino-Proby, Mario Rafael
Marquez-G., Pedro Jesus
Martin, Francis I.
Martin, V. Dale
McArthur, Donald
McCluer, R. D.
McConnell, Robert B.
McDowell, Alfred Norman
Mencher, Ely
Merrill, William R.
Mix, Adrian Elroy
Moore, Bernard Nettleton
Morrison, Robert P.
Muhlemann, Rudolf
Nolan, Philip Edward
Otamendi-Blanco, Paul
Pardo, Georges
Patterson, Joseph M.
Payne, Arthur Lawrence
Pearce, Roy Ward
Pfeffer, Guilford Clarence
Poulin, John A.

Ramsden, Charles Hugo
Regan, John H.
Renz, Hans Herman
Rincones, Carlos Antonio V.
Robie, Robert Hodges
Rummerfield, Ben F.
Salvador y Diaz, Amos
Saubert, Robert William
Schlatter, Lucas Eugen
Scott, Gerald Hugh
Severson, George A.
Sohlberg, Rudolph Gust
Spencer, Charles Grason
Staeger, Dietrich
Sugar, Ernst
Sutton, Frederick A.
Taylor, Spence Tomlinson
Thiebaud, Charles Emile
Thoms, Harold Wayne
Tribbey, Roy Jackson, Jr.
Weisbord, Norman E.
Wenberg, Edwin Hugo
Wheeler, Russell Benson
White, Gordon Ashbridge
Wilson, Joe G.
Wilson, Thomas C.
Winkler, Virgil Dean
Zaikowsky, Michael Wladimir
Zuloaga, Guillermo

CARIPITO

Ackerman, Edgar Dumont
Dahm, John N.
Howard, Douglas Duke
Loeffler, Richard John
Seals, Wilburn Hale
Simons, James A.
Walla, Joseph, Jr.
Yolton, James S.

CUMAREBO

Myers, LeMoyne Ward

JUSEPIN—Becker, Leroy Everett

MARACAIBO

Butcher, Walter W.
Crews, William Edward
Current, Andrew Max
Davis, Irion Grady
Dominguez-D., Jose Rafael
Douglas, John G.
Finley, Emmett Atkins
Gester, Peter Warren
Johnson, Frank Walker
Johnson, Hamilton McKee
Lamon, Robert Scott
LeRoy, Leslie Walter
Martin, Bethea A.
Martin, Rudolf
Netick, Joe
Ratway, Joseph
Roberts, Homer Eugene
Rogers, Harry Samuel
Sawyer, Joseph Herbert
Taylor, Henry Stanley
Weber, David M.
Whipple, G. Leslie

MATURIN—Benson, Don G.
Borger, Harvey D.
Short, Don Clifton
Sinclair, John Taylor, Jr.

FINANCIAL STATEMENT FOR THE YEAR 1946

To the Executive Committee
of The American Association of Petroleum Geologists:

We have examined the balance sheet of THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS at December 31, 1946, and the statement of income and surplus for the year then ended, have reviewed the system of internal control and the accounting procedures of the Association and, without making a detailed audit of the transactions, have examined or tested accounting records of the Association and other supporting evidence, by methods and to the extent we deemed appropriate. Our examination was made in accordance with generally accepted auditing standards applicable in the circumstances and included all procedures which we considered necessary.

In our opinion, the accompanying balance sheet and statement of income and surplus present fairly the position of the THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS at December 31, 1946, and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

(Signed) ARTHUR YOUNG & COMPANY

TULSA, OKLAHOMA
February 4, 1947

EXHIBIT A
BALANCE SHEET
AT DECEMBER 31, 1946

ASSETS	*Total*	*General Fund*	*Publication Fund*	*Research Fund*	*Powers Medal Fund*	*Life Membership Fund*
CURRENT ASSETS:						
Demand deposits	$ 58,073.75	$ 45,529.51	$ 8,624.05	$3,268.94	$ 451.25	$ 200.00
Accounts receivable less reserve, $528.05	3,163.77	3,087.42	76.35	—	—	—
Accrued interest receivable less reserve, $795.41	553.98	305.06	140.18	1.45	107.29	—
TOTAL CURRENT ASSETS	$ 61,791.50	$ 48,921.99	$ 8,840.58	$3,270.39	$ 558.54	$ 200.00
INVESTMENTS at cost (market value $154,358.12)	153,104.50	109,635.48	29,632.21	1,736.81	9,300.00	2,800.00
PUBLICATIONS (see note)	7,391.67	4,615.12	2,776.55	—	—	—
FURNITURE AND FIXTURES less reserve, $5,772.27	1.00	1.00	—	—	—	—
DEFERRED CHARGES	8,779.13	5,635.13	3,144.00	—	—	—
TOTAL ASSETS	$231,067.80	$168,808.72	$44,393.34	$5,007.20	$9,858.54	$3,000.00
LIABILITIES AND SURPLUS						
CURRENT LIABILITIES:						
Accounts payable	$ 3,076.54	$ 3,076.54	$ —	$ —	$ —	$ —
Accrued printer's charges	7,814.07	4,670.07	3,144.00	—	—	—
TOTAL CURRENT LIABILITIES	$ 10,890.61	$ 7,746.61	$ 3,144.00	$ —	$ —	$ —
DEFERRED INCOME (membership dues and subscriptions $34,032.96, advertising $811.25)	34,844.21	34,844.21	—	—	—	—
SURPLUS (Exhibit B)	185,332.98	126,217.90	41,249.34	5,007.20	9,858.54	3,000.00
TOTAL LIABILITIES AND SURPLUS	$231,067.80	$168,808.72	$44,393.34	$5,007.20	$9,858.54	$3,000.00

NOTE: Publications, exclusive of excessive quantitites and obsolete issues, were priced as follows:

Bulletins—
1946 issues at cost
1942 to 1945 issues at $.50 each but not exceeding 100 copies of any one issue

Volumes—
At or below cost but not exceeding 100 copies of any one volume

Other publications—
At cost

EXHIBIT B
STATEMENT OF INCOME AND SURPLUS
FOR THE YEAR ENDED DECEMBER 31, 1946

	Total	*General Fund*	*Publication Fund*	*Research Fund*	*Powers Medal Fund*	*Life Membership Fund*
INCOME:						
Membership dues for 1946 (3,799 active, 1,085 associate, 3 life)	$ 46,894.00	$ 46,294.00	$ —	$ —	$ —	$ 600.00
Less: $6.00 per member transferred to "Income from Publications"	29,322.00	29,322.00	—	—	—	—
	$ 17,572.00	$ 16,972.00	$ —	$ —	$ —	$ 600.00
Income from publications (Schedule 2)	24,562.49	22,238.25	2,324.24	—	—	—
Income from securities	4,852.88	3,767.94	817.00	33.99	233.95	—
Recovery of accounts previously charged off	902.04	888.39	13.65	—	—	—
Profit from sale of securities	336.97	245.00	—	91.97	—	—
Miscellaneous	268.18	168.18	—	—	100.00	—
TOTAL INCOME	$ 48,494.56	$ 44,279.76	$ 3,154.89	$ 125.96	$ 333.95	$ 600.00
EXPENSES (exclusive of expenses charged to "Income from Publications"):						
Salaries	$ 14,142.80	$ 14,142.80	$ —	$ —	$ —	$ —
Postage	2,904.71	2,904.71	—	—	—	—
Office rent	2,485.50	2,485.50	—	—	—	—
Miscellaneous office supplies and expenses	4,374.15	4,374.15	—	—	—	—
Taxes	275.86	275.86	—	—	—	—
Provision for bad debts	802.26	802.26	—	—	—	—
Index expense	1,637.62	1,637.62	—	—	—	—
Traveling expense	1,631.89	1,631.89	—	—	—	—
Research projects	2,293.30	2,293.30	—	—	—	—
Investment counsel	400.00	400.00	—	—	—	—
Audit fee	300.00	300.00	—	—	—	—
Convention expense—net	1,089.97	1,089.97	—	—	—	—
Donation to Society of Economic Paleontologists and Mineralogists	1,500.00	1,500.00	—	—	—	—
Distinguished lecture committee	500.00	500.00	—	—	—	—
Medals and awards	135.86	135.86	—	—	—	—
Miscellaneous	914.31	697.46	216.85	—	—	—
TOTAL EXPENSES	$ 35,388.23	$ 35,171.38	$ 216.85	$ —	$ —	$ —
NET INCOME	$ 13,106.33	$ 9,108.38	$ 2,938.04	$ 125.96	$ 333.95	$ 600.00
SURPLUS AT DECEMBER 31, 1945	172,226.65	119,263.18	38,311.30	2,727.58	9,524.59	2,400.00
TRANSFER TO RESEARCH FUND	—	(2,153.66)	—	2,153.66	—	—
SURPLUS AT DECEMBER 31, 1946	$185,332.98	$126,217.90	$41,249.34	$5,007.20	$9,858.54	$3,000.00

SCHEDULE 2[1]—STATEMENT OF INCOME FROM PUBLICATIONS FOR YEAR ENDED DECEMBER 31, 1946

	Total		General Fund		Publication Fund	
INCOME:						
Membership dues transferred		$29,322.00		$29,322.00		
Bulletin subscriptions		6,752.49		6,752.49		
Advertising—net		22,591.73		22,591.73		
Sales of bound volumes and special publications—						
Bound volumes of Bulletins	$ 3,139.75		$ 3,139.75			
Back numbers of Bulletins	3,077.16		3,077.16			
Possible Future Oil Provinces of the United States and Canada	245.65		245.65			
Tectonic Map of the United States	2,184.85		2,184.85			
Index	19.40		19.40			
Directory of Geological Material in North America	76.50		76.50			
Review of Petroleum Geology	307.50		307.50			
Geology of Natural Gas	124.20				$ 124.20	
Geology of Tampico Region	323.45				323.45	
Gulf Coast Oil Fields	89.80				89.80	
Tectonic Map of Southern California	49.60				49.60	
Miocene Stratigraphy of California	510.05				510.05	
Source Beds of Petroleum	598.50				598.50	
Stratigraphic Type Oil Fields	1,606.70				1,606.70	
Other publications	86.29	12,439.40	78.29	9,129.10	8.00	$3,310.30
TOTAL INCOME		$71,105.62		$67,795.32		$3,310.30
COSTS AND EXPENSES:						
Proportion of salaries and editor's expenses	$ 9,073.11		$ 9,073.11			
Printing Bulletins	25,965.83		25,965.83			
Engraving	2,337.40		2,337.40			
Stencil corrections and mailing	112.54		112.54			
Bulletin mailing and expense	1,170.20		1,170.20			
Copyright fees	24.00		24.00			
Special insert charges	2,532.49		2,532.49			
Binding Volume XXIX (1945)	836.73		836.73			
Reprints	615.44		615.44			
Printing Directory of Geological Material in North America	320.87		320.87			
Review of Petroleum Geology expense	120.91		120.91			
Other publications—freight, express, and postage	131.05				$ 131.05	
Miscellaneous	45.73		45.73			
TOTAL COSTS AND EXPENSES	$43,286.30		$43,155.25		$ 131.05	
Adjustment for decrease in inventory of Publications	3,256.83	46,543.13	2,401.82	45,557.07	855.01	986.06
NET INCOME FROM PUBLICATIONS		$24,562.49		$22,238.25		$2,324.24

Schedule 1 is not published.

FINANCIAL STATEMENT, DIVISION OF PALEONTOLOGY AND MINERALOGY, FOR THE YEAR 1946

To the Council
of Society of Economic Paleontologists and Mineralogists:

We have examined the balance sheet of SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS at December 31, 1946, and the statement of income for the year then ended, have reviewed the system of internal control and the accounting procedures of the Society and, without making a detailed audit of the transactions, have examined or tested accounting records of the Society and other supporting evidence, by methods and to the extent we deemed appropriate. Our examination was made in accordance with generally accepted auditing standards applicable in the circumstances and included all procedures which we considered necessary.

In our opinion, the accompanying balance sheet and statement of income present fairly the position of SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS at December 31, 1946, and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

(Signed) ARTHUR YOUNG & COMPANY

TULSA, OKLAHOMA
February 4, 1947

BALANCE SHEET
AT DECEMBER 31, 1946

ASSETS

CURRENT ASSETS:		
Demand deposits		$ 6,306.26
Savings deposit		2,276.62
Accounts receivable less reserve, $17.87		43.73
TOTAL CURRENT ASSETS		$ 8,626.61
PUBLICATIONS:		
25,006 Journals of Paleontology issued prior to 1946 (comprising 4,222 complete volumes) at $.50 per Journal	$12,503.00	
1,065 Journals of Paleontology, issues 1 to 6 of 1946, at cost	1,027.60	
4,323 Journals of Sedimentary Petrology issued prior to 1946 (comprising 1,467 complete volumes) at $.50 per Journal	2,161.50	
209 Journals of Sedimentary Petrology, issues 1, 2, and 3 of 1946, at cost	153.01	15,845.11
FURNITURE AND FIXTURES less reserve, $439.30		98.74
DEFERRED CHARGES		162.24
TOTAL ASSETS		$24,732.70

LIABILITIES AND SURPLUS

CURRENT LIABILITIES:		
Accounts payable		$ 1,295.78
Amount payable to Paleontological Society		954.84
Accrued printer's charges		162.24
TOTAL CURRENT LIABILITIES		$ 2,412.86
DEFERRED INCOME:		
Subscriptions to Journals	$ 2,196.95	
Membership dues for 1947 and 1948	1,398.72	3,595.67
SURPLUS:		
Balance, December 31, 1945	$18,909.21	
Net (loss) for year ended December 31, 1946 (per statement attached)	(185.04)	
Balance, December 31, 1946		18,724.17
TOTAL LIABILITIES AND SURPLUS		$24,732.70

STATEMENT OF INCOME FOR YEAR ENDED DECEMBER 31, 1946

INCOME:		
Membership dues and subscriptions—		
Journal of Paleontology and Sedimentary Petrology	$ 904.00	
Journal of Paleontology	3,568.18	
Journal of Sedimentary Petrology	1,251.18	$5,723.36
Sales of back numbers—		
Journal of Paleontology	$1,471.20	
Journal of Sedimentary Petrology	547.30	2,018.50
Sales of plates and reprints		236.64
Advertising		62.46
Donation from The American Association of Petroleum Geologists		1,500.00
Miscellaneous		34.73
TOTAL INCOME		$9,575.69
Less: Proportion of income accrued to Paleontological Society		954.84
INCOME		$8,620.85
COSTS AND EXPENSES:		
Cost of printing—		
Journal of Paleontology	$3,918.82	
Journal of Sedimentary Petrology	1,337.82	
	$5,256.64	
Clerical salaries	1,040.00	
Office supplies and expenses	158.94	
Office rent	405.00	
Insurance and bond	54.85	
Donation to Department of Micropaleontology of American Museum of Natural History	500.00	
Postage, telegraph, and delivery expense	429.79	
Audit fee	100.00	
Taxes	15.60	
Depreciation	53.80	
Miscellaneous	25.95	
TOTAL COSTS AND EXPENSES	$8,040.57	
Adjustment for decrease in inventory of publications	765.32	8,805.89
NET (LOSS)		$ (185.04)

MID-CONTINENT REGIONAL MEETING, WICHITA, KANSAS, JANUARY 15–17, 1947[1]

FRANK GOUIN[2]
Duncan, Oklahoma

The Mid-Continent regional meeting of the A.A.P.G. held at Wichita, Kansas, on January 15–17, 1947, sponsored by the Kansas Geological Society, proved the value of this type of meeting from every standpoint.

A bit of history about regional meetings may be interesting to both oldtimer and newcomer.

In looking back over the history of the Association, we find that the regional meeting has not been a regular, or even frequent, event. Such occasional meetings in the past, held at various dates between annual conventions, are indeed relatively so rare that they are particularly memorable. Some of the members attending the current meeting will recall the first regional meeting of the Association, held in Denver, October 26, 27, and 28, 1922. "Daddy" Decker,[3] then secretary, recorded

> Sixty-three papers of high scientific value were scheduled . . . and most of them . . . were presented and discussed in the meeting. . . . The climax of the social features was reached at the Association dinner Friday evening in the Magnolia Room of the Albany Hotel, at which about one hundred and thirty were present. The program was one of great originality. Max W. Ball served admirably as toastmaster and the toasts included "Stories of My Friend The Plainsman" by C. H. Wegemann; "How Old Was Nebuchadnezzar" and "How Old is Petroleum" by Rimrock Jones of Poison Spider; "The Interests of the Association" by W. E. Wrather; "The Making of a Pebble Pup" by E. F. Schramm; and "The Law Hound" and the "Rock Hound" by Wilfrid O'Leary. A number of original songs written for the occasion were interspersed with the toasts.
>
> At the close of the meeting a group of the men started Saturday evening on a trip to the Salt Creek field near Casper, Wyoming, but a terrible blizzard caught them on the way out from Casper, causing them to return to that city without reaching the field.

"Bill" Wrather[4] stated in his presidential report covering the year 1922,

> Foremost among Association activities of the past year was the eminently successful meeting held in Denver during October. . . . It does not seem advisable that the Association should now be committed to an established policy of holding a mid-year meeting each year. . . . But mid-year meetings can be of such decided advantage both to the Association and to its local contingents of members that they should be sanctioned and encouraged, perhaps at irregular intervals, where, in the opinion of the executive committee, the local demand is sufficiently enthusiastic and well grounded.

Los Angeles was the place of the second mid-year meeting, in September, 1923. Max Ball reported,

> There is no need to describe the mid-year meeting held at Los Angeles in September. Those who were there are still talking about it. These mid-year meetings widen the influence of the Association among oil men, bring the Association in contact with many geologists not otherwise accessible, lessen the dangers of sectional feeling inside the Association, and stimulate the flow of excellent material to the *Bulletin*. Though it may not be wise to hold one every year, the general idea of the mid-year meeting seems to have come to stay.

In September of 1926 an even hundred of us collected at Denver with seventy-five guests to attend a joint meeting with the A.I.M.E. and the A.M.G., and Alex McCoy demonstrated his bulletin-board method of presenting an extended technical program in

[1] Manuscript received, January 22, 1947.

[2] Independent geologist.

[3] Charles E. Decker, "Denver Meeting of the American Association of Petroleum Geologists," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 6, No. 6 (November–December, 1922), pp. 557–58.

[4] W. E. Wrather, "Report of the President," *ibid.*, Vol. 7, No. 3 (May–June, 1923), p. 308.

conjunction with a short oral program. In November of the same year, the New York committee of the A.A.P.G. sponsored the fall meeting in New York City, and an important result of the efforts of that committee was the Association Revolving Publication Fund. During the last three days of 1931, the Tulsa Geological Society sponsored the next mid-year meeting in connection with the annual meeting of the Geological Society of America, and several hundred members were present. The only meeting of the Association

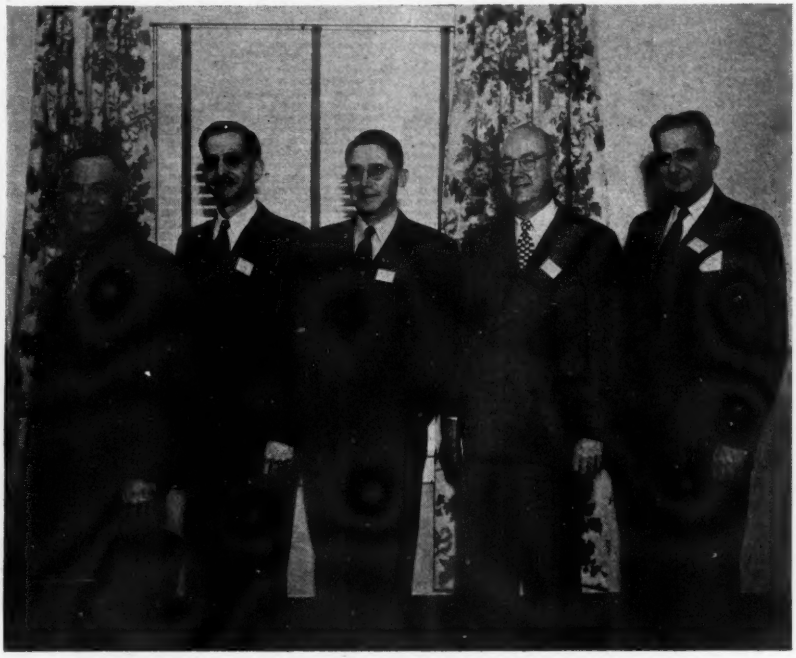

FIG. 1.—A.A.P.G. executive committee at Wichita. Left to right: Gayle Scott, editor; Edward A. Koester, secretary-treasurer; Monroe G. Cheney, past-president; Earl B. Noble, president; D. Perry Olcott, vice-president. (Photo by courtesy of Wichita *Beacon*.)

outside the boundaries of the United States was the mid-year meeting of October, 1935, held in Mexico City, under the sponsorship of the San Antonio Geological Society. In October of 1937 a mid-year meeting was held in Pittsburgh when 110 members and 112 guests were in attendance. The last meeting to be called a mid-year meeting was that sponsored by the West Texas Geological Society of Midland in El Paso from September 22 to October 2 of 1938 when 206 members and 180 guests were given an extremely interesting program of papers and field trips.

Naturally, meetings other than the regular business meeting of the Association were curtailed during the war years. Certainly it was a happy and fruitful thought of the executive committee to re-inaugurate the type of meeting that began this A.A.P.G. year with the Gulf Coast regional meeting held in Biloxi in late October in 1946 and sponsored by the Mississippi Geological Society. The fact that 477 members and 110 guests were in

attendance, to make a record, up to that time, for any type of meeting held between annual conventions, was proof enough of the value of, and the interest shown in, such meetings.

If any member had any doubt as to the advisability of conducting regional meetings such doubts would have been dispelled completely at the Wichita meeting where 476 members and 428 guests were entertained in a manner that was perfection. It must be the long

FIG. 2.—Officers and committee chairmen at Wichita. Front row, left to right: Gayle Scott, A.A.P.G. editor; M. W. Smith, reception chairman; Earl B. Noble, A.A.P.G. president; M. J. Boreing, entertainment chairman; John L. Garlough, registration chairman. Standing, left to right: D. Perry Olcott, A.A.P.G. vice-president; E. C. Moncrief, general chairman; K. T. Woodman, finance chairman; Monroe G. Cheney, A.A.P.G. past-president; Edward A. Koester, A.A.P.G. secretary-treasurer; J. P. D. Hull, A.A.P.G. business manager.

years of training in conducting those famous field trips which gives the members of the Kansas Geological Society the knowledge of how to arrange such a meeting so perfectly. While it was apparent that every member of the Society worked hard both in preparation for and during the meeting, space permits only mention of the committee chairmen. E. C. Moncrief as general chairman seemed to be everywhere at the same time. He was a very active member of every one of the sub-committees with special emphasis on the reception committee. Ed Koester as program chairman with his committee worked out a program of papers that were extremely well balanced, and ran them off on schedule. Millard Smith and his reception committee were the unsung heroes of the meeting. They handled a very "tight" hotel situation in a manner that created a minimum of discomfort. The registration committee headed by John Garlough plus the efficient office staff from Tulsa had things

working smoothly throughout. Bud Boreing and his entertainment committee must have performed their tasks with super-efficiency, judged by the comments of those in attendance. The fact that the whole meeting seemed to work smoothly proved that the finance committee headed by K. T. Woodman must have done its job right. The list of contributors on the last page of the program attested to this. Gail Carpenter, president, Lee Cornell, vice-

FIG. 3.—A.A.P.G. headquarters staff at Wichita: seated, left to right: Condray Blair, Nadine Spencer. Standing, left to right: Elmer W. Ellsworth, Alyce Ruth Goodner, J. P. D. Hull.

president, and Don Payne, secretary-treasurer of the Society, presided at meetings and were otherwise in evidence throughout the sessions.

The management of the Broadview Hotel, the meeting headquarters, was pleasingly attentive to the needs of all, and the Wichita Chamber of Commerce furnished complimentary services at the registration counter. The A.A.P.G. headquarters staff was on hand to assist in details of registration and in the work of various committees.

The meeting opened at 9:00 A.M. Wednesday with a meeting of the entire membership of the executive committee of the Association. At the same time "Shep" Lowman began meetings of his research committee, which meetings continued through the entire day. At 3:00 P.M. Leo Fortier presided at a meeting of the committee on applications of geology. Robert Dott met with his committee on geologic names and correlations, concluding on Thursday morning at a breakfast meeting. Wednesday night the Kansas Geological Society was host at an open house in the Bamboo Room of the Broadview Hotel where everyone got acquainted with anyone he did not know. It was a grand get-together to the extent that it was possible for everybody to do all his visiting that night which probably

explains the very high percentage of those registered in attendance when the papers were presented on the two days following.

Four papers were given on Thursday morning after the address of welcome by E. Gail Carpenter, president, Kansas Geological Society: "The Norman Wells Oil Field," by J. S. Stewart; "Marine Pool, Madison County, Illinois, a Reef Producer," by H. A. Lowenstam; "Kraft-Prusa Oil Field, Central Kansas," by Robert F. Walters and Arther S. Price; "The Geneseo Uplift, Rice, Ellsworth, and McPherson Counties, Kansas," by S. K. Clark, C. L. Arnett, and James D. Royds. President Earl Noble of the Association finished the morning session by giving a talk on "Association Affairs."

The Thursday afternoon session began with an extremely illustrative talk by R. B. ("Ike") Downing and V. J. ("Mike") Mercier entitled, "Radioactivity Logs in Limestone Reservoirs." They used the "flip-board," developed for army use during the war. "Moran-Kisinger Field, Young County, Texas," was given by past-president Monroe Cheney. He pointed out the unusually large cumulative production of one well in the field as compared with the average of other wells by reason of the fortunate location of that well in a rich spot in the field. W. Y. Pickering and C. L. Dorn presented a paper entitled, "The Rangely Oil Field, Rio Blanco County, Colorado," that was especially interesting to the writer, in their account of the continuous core of more than 800 feet of the Weber sand zone taken with a diamond core bit. "Unusual Oil Fields in the Rocky Mountain Region of United States," by C. E. Dobbin, was a very refreshing and informative review of many widespread areas in the region "Cy" knows so well. The afternoon meeting closed with a paper by L. C. Morgan, Caldwell Starky, and R. K. Lanyon entitled, "The Hugoton Gas Field, Kansas, Oklahoma, and Texas." It was quite evident that the long time these men have been working in this area has made them authorities on this vast gas reserve.

Thursday night it required two large ballrooms on the Broadview roof with an excellent orchestra in each to take care of the crowd. This was the beginning of entertainment for the women which culminated next afternoon—Friday—in an open house and style show at which the many women guests present were given beautiful favors for their handbags. In all of the entertainment for the women it was quite evident that the wives of the members of the Kansas Geological Society were as busy as their husbands. Mrs. John W. Inkster was chairman of the committee on general arrangements. Serving with her were Mrs. James I. Daniels, Mrs. Sherrill A. Shannon, and Mrs. Wayne Walcher. The entertainment committee was headed by Mrs. Robert B. McNeely, with Mrs. Benton S. Brooks, Mrs. N. D. Clark, and Mrs. Kenneth Reid serving with her. The women guests present were unanimous in their praise of the entertainment. This probably presages a large percentage of wives in attendance at the annual meeting in Los Angeles the last week in March.

The first paper of the Friday morning session was by past-president Ira H. Cram entitled, "Regional Structure of the Mid-Continent Region." It was really a foundation for all the papers presented at the meeting. An early publication of this paper in the *Bulletin* would be a distinct service to the members of the Association. This was followed by a paper by Robert M. Swesnik entitled, "Geology of the West Edmond Oil Field, Central Oklahoma." "Geology of Hunton Limestone Cores, West Edmond Oil Field, Central Oklahoma," by J. T. Richards, described the cores taken from the top to the bottom of the Hunton limestone. The last paper of the morning, sponsored by our sister organization, the Society of Exploration Geophysicists, by B. G. Swan and Baxter Boyd, entitled, "Geophysical History of the Guthrie Oil Field, Logan County, Oklahoma," was an interesting account of the geophysical history of the discovery and development of the field.

The Friday afternoon session began with a paper by Lon B. Turk entitled, "Antioch Oil Field, Garvin County, Oklahoma." "Anadarko Basin Oil Possibilities," which was read by Robert R. Wheeler, was very well received in view of the interest in that general area at this time. It took the inimitable Harry W. Oborne to bring out the laughs when he dis-

cussed "Oil Possibilities of the Las Animas Arch and Adjacent Areas of Eastern Colorado." His remarks found a sympathetic response from many of his audience who personally appreciated his experiences. "Geophysics in the Mid-Continent—Past Results and Future Application," by G. H. Westby, was a worth-while paper on the geophysical tools used by the geologist and a challenge to all geologists to put these tools to work in areas where each will do the most good for the time and expense involved.

The afternoon session closed with a paper by Joseph R. Clair and Fanny C. Edson entitled, "Lithologic Criteria for Subdivision of the Arbuckle Dolomite in Far Western Kansas and Adjoining States."

This was the final paper of the sessions.

At the beginning of the meeting president Noble stated, "Keyed to the twin themes 'Unusual Oil Fields' and 'Future Oil Possibilities of the Mid-Continent Area,' this meeting should well fulfill the A.A.P.G.'s objective in re-establishment of the regional meeting; to broaden the perspective of local groups within the area of their immediate interests." The slogan of the meeting was "Look Back—Then Look Forward." There is no question that everyone in attendance was well repaid in coming. The value of the meeting to the younger members was evidenced by the large number coming from their various company duties from as far away as Midland, Denver, Washington, New Orleans, Houston, and Casper, not to mention almost every city where geologists reside in Oklahoma and Kansas. In future years we will wonder how we were able to get along without such meetings for so long a time. The writer is one who hopes they are now firmly established, and that it will be possible for more of the members to attend.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 31, NO. 3 (MARCH, 1947), PP. 650-652, 2 FIGS.

MEMORIAL

LON LEWIS HUTCHISON
(1877–1947)

Lon Lewis Hutchison was born in Marion County, Kansas, July 26, 1877, son of Humphrey Lewis Hutchison and Annie D. (Smith) Hutchison. Soon after the opening of

LON LEWIS HUTCHINSON

Oklahoma to settlement, when he was a small boy, the family moved to Oklahoma, and settled on a farm a few miles north of Perry, Noble County.

After completing the common schools Mr. Hutchison enrolled in the preparatory department of the University of Oklahoma at which school he remained until graduation in 1907. In the meantime, he had become interested in the science of geology and spent two

summer vacations traveling in a covered wagon studying the stratigraphy of the oil fields of northeastern Oklahoma.

In October, 1907, he married Miss Jessie Pennington, daughter of James E. Pennington of Norman, Oklahoma, and one of his fellow-students at the University of Oklahoma.

After completing his work at Oklahoma he spent a year at Yale University from which school he received the degree of Master of Science in 1908. With the organization of the Oklahoma Geological Survey in July, 1908, Mr. Hutchison was appointed assistant director and was placed in charge of a field party that worked in Tulsa, Creek, Okmulgee, Muskogee, and Wagoner counties. As assistants he had Ben C. Belt, Artie C. Reed, and W. J. Cross.

He was joint author of *Circular No. 1* of the Survey, entitled "The Oklahoma Geological Survey, Its Origin, Scope and Purpose"; also of *Bulletin No. 1*, entitled "Preliminary Report on the Mineral Resources of Oklahoma." He prepared for publication the first official report on the petroleum and asphalt resources of the state, published in 1911 as *Bulletin No. 2* of the Survey, entitled "Rock Asphalt, Asphaltite, Petroleum and Natural Gas of Oklahoma."

In 1910 Mr. Hutchison opened an office as consulting geologist in Tulsa, where he resided until his death on January 13, 1947. He was the first man in the state to devote his entire time to petroleum geology.

Soon after coming to Tulsa he organized the science department of the Tulsa High School. He was one of the first members of the American Association of Petroleum Geologists. He was instrumental in the development of several early oil fields in Oklahoma, notably the Cushing field where he was employed by the McMan Oil Company and by T. B. Slick. In 1913, he organized and became president of the Kanola Oil Company, and in 1915 he owned and operated a zinc mine in the Joplin, Missouri, area.

During the later years of his life Mr. Hutchison was an independent oil broker and was engaged in the real estate business, being an active member of the Tulsa Real Estate Board at the time of his death. He was active in earlier years in the American Institute of Mining and Metallurgical Engineers, the Mid-Continent Oil and Gas Association, the Oklahoma Academy of Science, the City Club of Tulsa, and the Tulsa Chamber of Commerce.

Mr. Hutchison is survived by his wife, who resides at 2219 East Thirteenth Street, Tulsa, Oklahoma; by a son, Captain Gregory Lewis Hutchison, Heidelberg, Germany; a daughter, Mrs. Carleton Paul Wright, Oklahoma City; and two grandchildren, Sandra Louise Wright and Bradley Lewis Wright.

CHARLES N. GOULD

NORMAN, OKLAHOMA
January 27, 1947

NEWELL MORRIS WILDER
(1908–1946)

The death, after a brief illness, of Newell Morris Wilder, at Lisbon Veterans' Hospital, Dallas, Texas, August 25, 1946, at the age of 38 years, brought to a close, a life rich in accomplishment and full of promise for the future.

He was honorably discharged in February, 1946, after four years of military service with the rank of Major in the United States Army.

Newell was one of six sons of the late A. S. and Mary A. Wilder of Corbin, Kentucky. He is survived by his wife, the former Gertrude Skinner of Saquoit, New York, and two daughters, Betsy 10 and Jane 7.

Newell was born at Corbin, Kentucky, June 13, 1908. He graduated from the Corbin High School in the class of 1927. He entered the Engineering College of the University of Kentucky in the fall of 1928. In 1931 he elected to major in geology and zoology. He received his B.S. in 1934 and an M.S. degree the following year.

Newell was active in sports and played varsity football. He is reported to have been the last Kentucky player to carry the ball in the last football game the Kentucky Wildcats played with the "Praying Colonels" of Center College of Danville, Kentucky, in 1929.

He was a member of Phi Sigma Kappa social and Sigma Gamma Epsilon professional geological societies.

Prior to his graduation he assisted in the compilation of publications for the Bureau of Mineral and Topographic Survey at the University. In July, 1934, he became a member

NEWELL MORRIS WILDER

of the staff of the State Department of Mines and Minerals. In that capacity, his work was principally along the line of petroleum geology and petroleum engineering and it was in these fields that he gained a wide reputation that made him an authority on secondary oil-recovery operations throughout Kentucky.

He was the author of a number of technical papers dealing with air and gas repressuring problems. His advice was sought by many who contemplated secondary-recovery activities.

"Newt," as he was affectionately called by his many friends, was one of those rare individuals who thrived on hard work. When he was overburdened, the addition of another assignment only brought forth a smile that signified his willingness to accept it.

Soon after his appointment he was asked to design and supervise the construction of the Repressuring Laboratory that was destined to halt the rapid and premature abandonment of partially depleted oil fields in Kentucky.

His outstanding work soon won him recognition and in March, 1937, he was offered a responsible position with Petroleum Exploration. He was placed in charge of their geological work as well as their extensive secondary oil operations.

Upon his release from the Armed Forces, Petroleum Exploration placed him in charge of their Wichita Falls, Texas, office which position he was holding at the time of his death.

D. J. JONES

LEXINGTON, KENTUCKY
January 20, 1947

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
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AT HOME AND ABROAD

CURRENT NEWS AND PERSONAL ITEMS OF THE PROFESSION

CHARLES N. GOULD, geologist of Norman, Oklahoma, gave a lecture before the Shawnee Geological Society on the "History of the Anadarko Basin and the Early Work Done on the Texas Panhandle," January 23, 1947.

G. W. LEPPER, formerly with the Petroleum Division, British Ministry of Fuel and Power, is associated with Burmah Oil Company, Ltd., 62 Southborough Road, Bickley, Kent, England.

WILLIAM W. RAND resigned from the Shell Oil Company, Inc., at Houston, Texas, on December 20, and is now living at 323 Lloyd Street, Santa Barbara, California. He was first employed as field geologist by Shell in 1926 in California.

New officers of the Southeastern Geological Society, Tallahassee, Florida, were elected January 10: president, H. A. SELLIN, Magnolia Petroleum Company; vice-president, B. B. SPAULDING, The Texas Company; secretary-treasurer, LOIS J. SCHULZ, The California Company.

R. A. CONKLIN will appreciate receiving any information about the current location and address of F. M. HACKBUSH, with whom he was connected in consulting work.

The following officers of the West Texas Geological Society, Midland, Texas, were elected on January 10: president, W. J. HILSEWECK, Gulf Oil Corporation; vice-president, W. A. WALDSCHMIDT, Argo Oil Corporation; secretary-treasurer, CHARLES F. HENDERSON, Stanolind Oil and Gas Company.

ROBERT R. WHEELER, Eason Oil Company, Enid, Oklahoma, spoke before the Oklahoma City Geological Society on the evening of January 10. His talk was entitled "Oil Possibilities of the Anadarko Basin."

LOUIS G. CAMERON, Shreveport, Louisiana, has resigned as district geologist with Midstates Oil Corporation, and is working as an independent operator in the Mid-Continent and Gulf Coast areas.

DONALD B. EICHER, after a 5-months' stay in the United States, has returned to Egypt where he is employed by the Standard Oil Company of Egypt, Box 607, Cairo, Egypt.

R. S. RHOADES, formerly with the Majestic Oil Corporation, is a consulting geologist at 10823 Wilshire Boulevard, Los Angeles 24, California.

DANIEL A. BUSCH, formerly with Huntley and Huntley, Pittsburgh, Pennsylvania, is in the exploration department of the Carter Oil Company Research Laboratory, Box 801, Tulsa, Oklahoma.

E. A. HUTCHINSON is associated with the Sunray Oil Corporation, 1007 Philtower Building, Tulsa, Oklahoma. He was formerly with the Bridgeport Oil Company, Inc., Wichita, Kansas.

HANS PETER SCHAUB may be addressed in care of Cia. Petrolera la Estrella de Cuba, Oficias 104, La Habana, Cuba. Previously he spent 8 years in Venezuela with the Caribbean Petroleum Company.

DAVID B. REGER, consulting geologist at Morgantown, West Virginia, is writing a series of articles on natural gas production and reserves for publication in the *Oil Weekly*.

KARL F. HASSELMANN, president of Salt Dome Oil Corporation, Houston, Texas, and a pioneer in Gulf Coast marine development, has introduced a new drill barge designed to operate in the 15-foot waters of Matagorda Bay.

The Fort Worth Geological Society has elected the following officers: president, C. D. CORDRY, Gulf Oil Corporation; vice-president, RICHARD H. SCHWEERS, The Texas Company; secretary-treasurer, RAYMOND W. DUDLEY, Pure Oil Company.

E. O. BUCK, Rowan Drilling Company, Houston, spoke before the Houston Geological Society, January 13, on the subject "Engineering and Geological Principles of Oil Well Drilling."

THOMAS L. BAILEY has left the Rothschild Oil Company to enter consulting practice. His address is 223 Chrisman Avenue, Ventura, California.

KENNETH E. BURG, former head of the geophysical department, Stanolind Oil and Gas Company, Tulsa, Oklahoma, has resigned to accept the position of consulting geophysicist with Geophysical Service Inc., 1311 Republic Bank Building, Dallas, Texas.

JOSEPH A. SHARPE, president of Geophysical Development Corporation, and vice-president of C. H. Frost Gravimetric Surveys, Inc., Tulsa, Oklahoma, spoke on "Recent Developments in Geophysical Exploration" before the January 20 meeting of the Tulsa Geological Society.

S. H. KNIGHT spoke on "The Physical Evolution of the Medicine Bow Mountains" at the January 24 meeting of the Wyoming Geological Association held in Science Hall, Laramie, Wyoming.

ELIOT BLACKWELDER, emeritus professor of geology at Stanford University, has been elected an honorary foreign member of the Geological Society of London, in recognition of "his distinguished contributions to the advancement of geological science." A member of the National Academy of Sciences, Blackwelder is also a past vice-president of the American Association for the Advancement of Science, and an honorary member of the Geological Society of China. He retired from active teaching in 1945, after 23 years as executive of the Stanford department of geology.

New officers of the Dallas Geological Society are as follows: president, WILLIS G. MEYER, of Meyer and Achtschin; vice-president, JOHN M. CLAYTON, Seaboard Oil Company; secretary-treasurer, W. W. NEWTON, Geotechnical Corporation; executive committee member, H. C. VANDERPOOL, Seaboard Oil Company.

HENRY L. BOND has been transferred from the Phillips Colombian Oil Company to Phillips Venezuelan Oil Company, Apartado 19, Barcelona, Venezuela, as subsurface geologist on properties in eastern Venezuela.

Following are the new officers of the Panhandle Geological Society, Amarillo, Texas: president, A. R. ERICKSON, Phillips Petroleum Company; vice-president, PAT MAHOLIN, Sinclair Prairie Oil Company; secretary-treasurer, ROBERT J. GUTRU, Cities Service Company.

ROBERT M. SWESNIK, Anderson-Prichard Oil Corporation, Oklahoma City, Oklahoma, delivered a paper on "The Geology of the Southwest Antioch Field, Garvin County, Oklahoma" before the Tulsa Geological Society on February 3.

JOHN R. CRAIN, Tulsa, Oklahoma, has resigned as division geologist with Ashland Oil and Refining Company in order to practice as a geological consultant. His address is 1307 South Pittsburgh, Tulsa.

WILLIAM M. SCHULZ, Cities Service Oil Company district geologist, Mt. Pleasant, Michigan, has been elected 1947 chairman of the Michigan chapter of the American Petroleum Institute.

J. P. JOHNSON may be addressed in care of the Geological Exploration Department, Creole Petroleum Corporation, Apartado 889, Caracas, Venezuela.

BENJAMIN A. DALEON may be addressed at 7 Merchant Street, Lucena, Quezon Province, Philippines.

HENRY C. COOKE, formerly with Southern Minerals Corporation, is associated with O. G. MCCLAIN, consulting geologist, 224 Nixon Building, Corpus Christi, Texas.

NORVAL E. BAKER has moved from the London office of Iraq Petroleum Company, Ltd., to Room 930, 500 Fifth Avenue, New York 18, N. Y. He is chief geologist of the company.

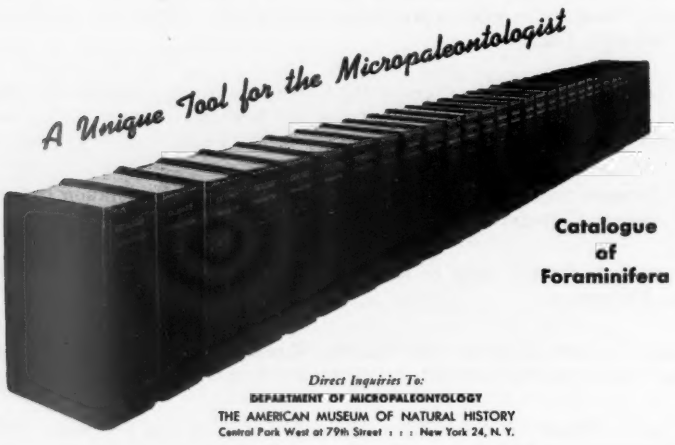
S. E. SLIPPER, formerly with Canadian Western Natural Gas, Light, Heat, and Power Company, Ltd., is practicing as a consulting geologist, with offices at 300 Albertan Building, Calgary, Alberta.

ALEXANDER H. MCKEE, formerly in the Pittsburgh, Pennsylvania, headquarters of Gulf Research and Development Company, may now be addressed in care of Danish American Prospecting Company, Asanigaarden, Viborg, Denmark.

PHILIP B. KING will devote the spring months of 1947 to tectonic and stratigraphic studies in Great Smoky Mountains National Park, Tennessee and North Carolina, where he is collaborating with JARVIS B. HADLEY of the United States Geological Survey and HERMAN W. FERGUSON of the Tennessee Division of Geology. This work is a phase of a general investigation of the park area being undertaken by the United States Geological Survey. While in the field, King may be reached in care of the National Park Service, Gatlinburg, Tennessee.

The Tulsa Geological Society has announced plans for a three-day field trip to be led by THOMAS A. HENDRICKS of the United States Geological Survey through the Ouachita Mountains, Oklahoma, May 8–10. The plan is to meet at Ada on the night of May 7, and to proceed to Atoka and McAlester on the first day, to Pittsburg, the frontal belt of the Ouachitas, and back to McAlester on the second day, and east to Wilburton and the Potato Hills area where the trip will terminate on the third day. Further details will be announced at a later date by C. T. JONES, chairman of the field-trip committee.

The Department of Micropaleontology of the American Museum of Natural History is attempting to recall sets of the Catalogue of Foraminifera issued to individual subscribers who have permitted their membership to lapse. This is being done in order that other individuals wishing to establish and maintain membership can be supplied with copies of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Regular Meetings: 7:30 P.M., Geological Room, University of Wichita, first Tuesday of each month. The Society sponsors the Kansas Well Log Bureau, 412 Union National Bank Building, and the Kansas Well Sample Bureau, 137 North Topeka.

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Meetings: Monthly, November through May, at Michigan State College, East Lansing, Michigan. Informal dinners at 6:30 P.M., followed by discussions. Visiting geologists are welcome.

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Meetings will be announced.

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Secretary-Treasurer - - - - - Philip R. Allin
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Meets the first Monday of every month, October-May inclusive, 7:30 P.M., St. Charles Hotel. Special meetings by announcement. Visiting geologists cordially invited.

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Meetings: Dinner and business meetings third Tuesday of each month at 7:00 P.M. at the Majestic Hotel. Special meetings by announcement. Visiting geologists are welcome.

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Skelly Oil Company

Meetings: First and third Thursdays of each month, from October to May, inclusive, at 7:30 P.M., Edwards Hotel, Jackson, Mississippi. Visiting geologists welcome to all meetings.

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Secretary-Treasurer - - - Murrell D. Thomas
The Texas Company, Box 539

Dinner meetings will be held at 7:00 P.M. on the first Wednesday of every month from October to May, inclusive, at the Ardmore Hotel.

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Vice-President - - - - - - - - - Harold J. Kleen
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965 First National Building

Meetings: Technical program each month, subject to call by Program Committee, Oklahoma City University, 24th Street and Blackwelder. Luncheons: Every second and fourth Thursday of each month, at 12:00 noon. Y.W.C.A.

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Meetings held each month, except during the summer. All meetings and other activities by special announcement.

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Luncheons: Each week, Monday noon, Blackstone Hotel.

Evening meetings and programs will be announced. Visiting geologists and friends are welcome.

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Regular meeting held the second and fourth Mondays at noon (12 o'clock), Mezzanine floor, Rice Hotel. For any particulars pertaining to the meetings write or call the secretary.

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Transwestern Oil Company, 1600 Milam Building
Secretary-Treasurer - - - - - Paul B. Hinyard
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Meetings: One regular meeting each month in San Antonio. Luncheon every Monday noon at Milam Cafeteria, San Antonio.

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Secretary-Treasurer - - - - - R. W. Dudley
Pure Oil Company
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Meetings: Luncheon at noon, Hotel Texas, first and third Mondays of each month. Visiting geologists and friends are invited and welcome at all meetings.

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Meetings: Second Monday, each month, except June, July, and August, at 6:30 P.M., Kanawha Hotel.

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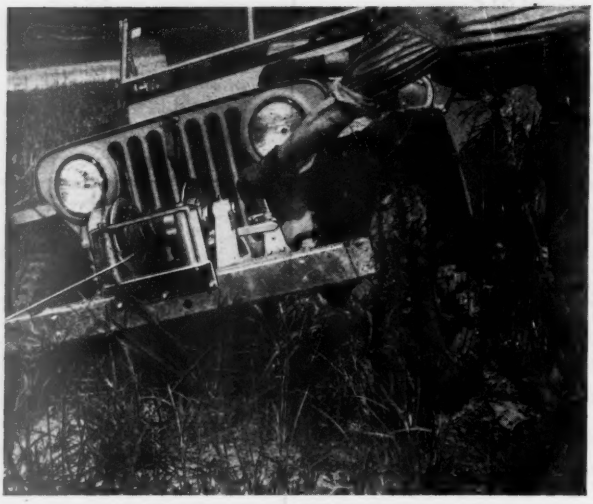

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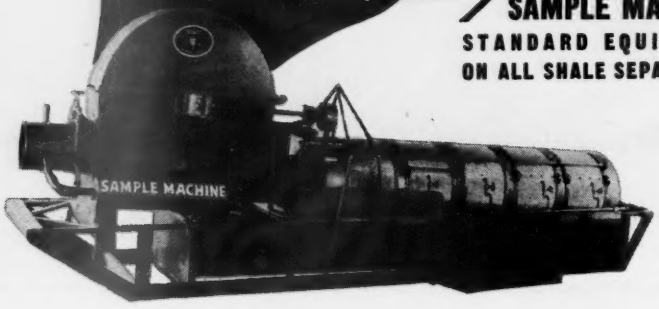

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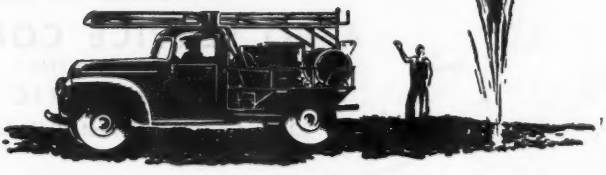

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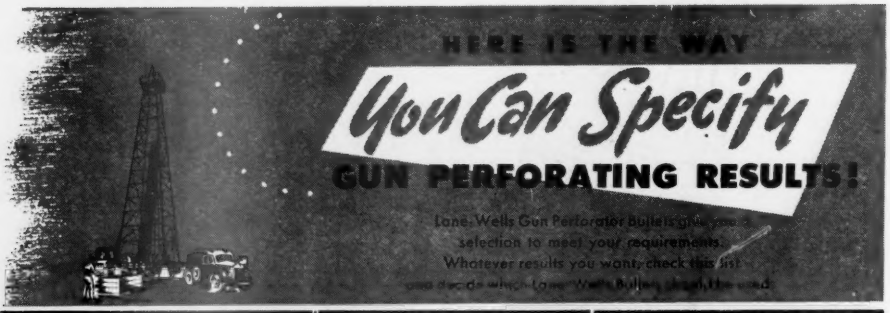

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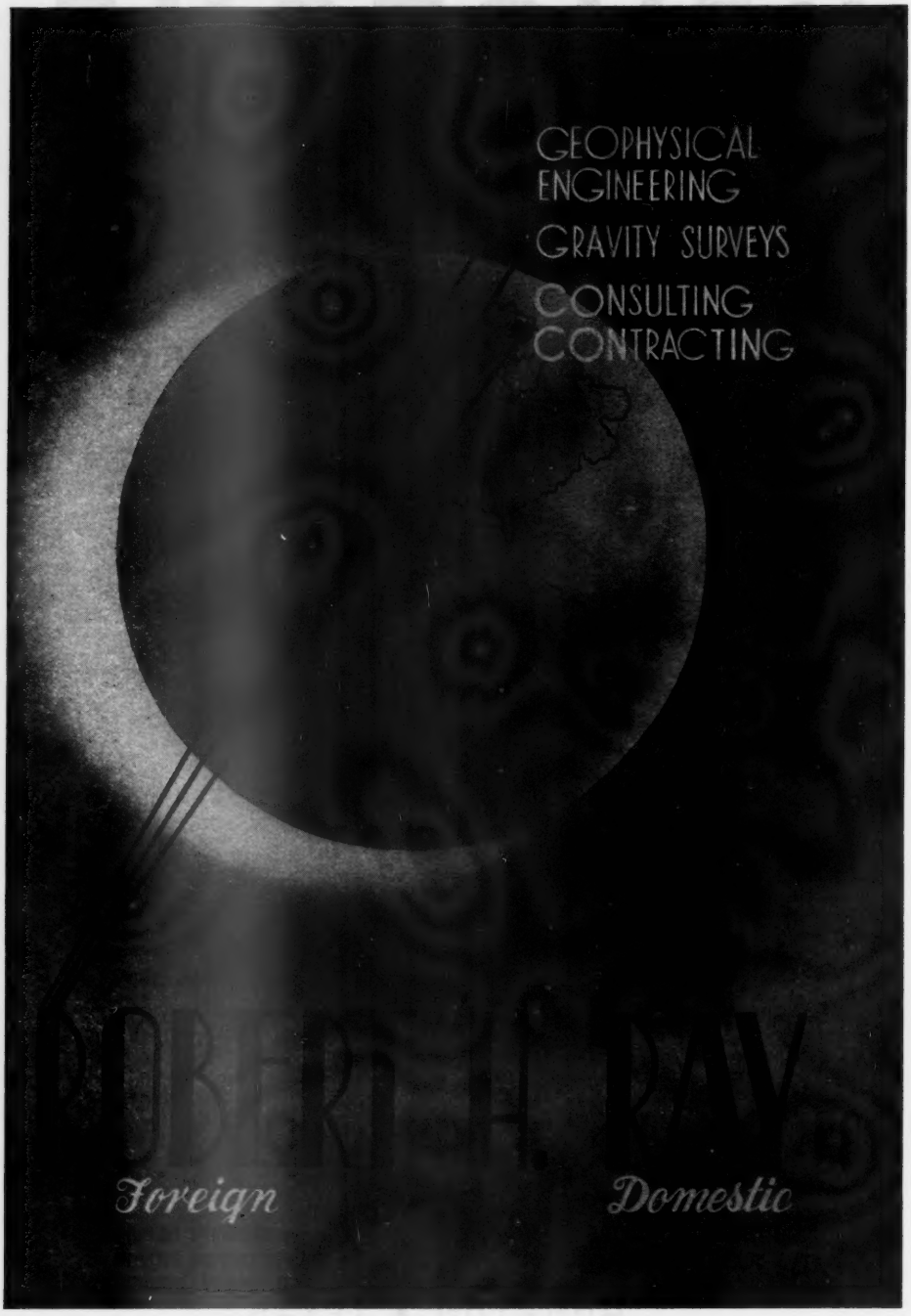
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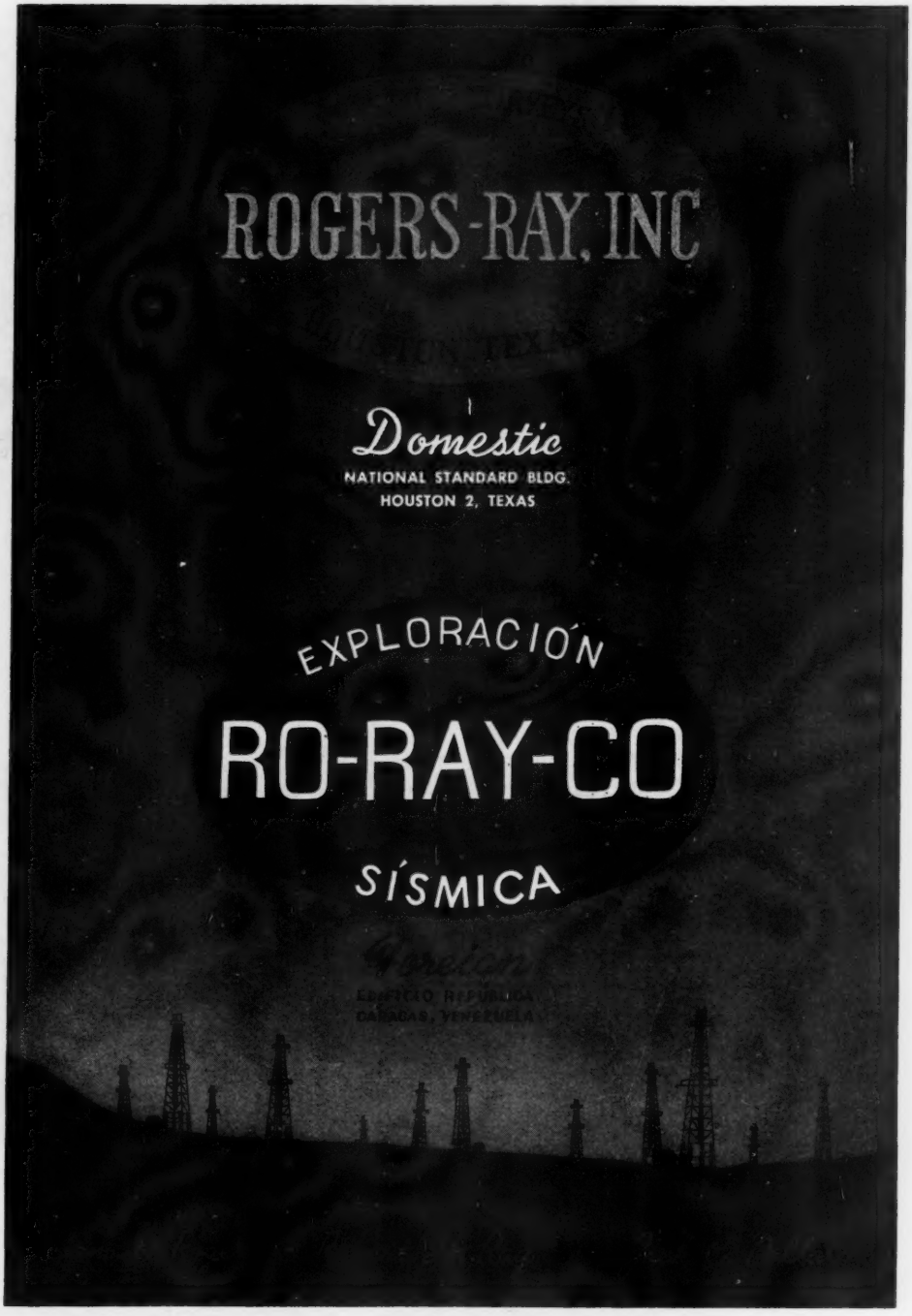
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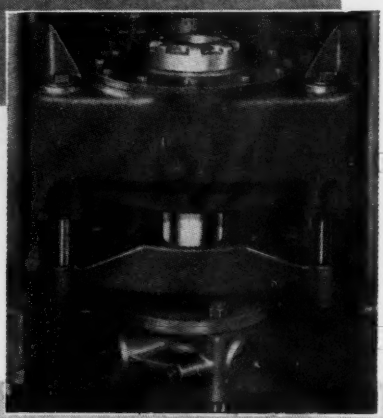

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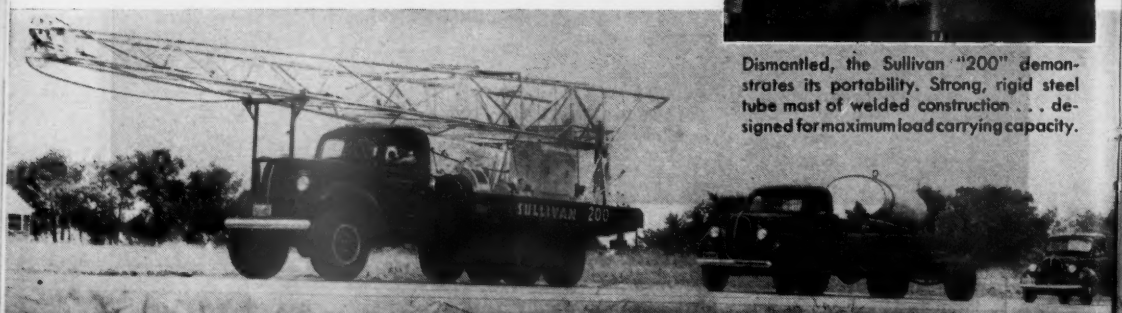

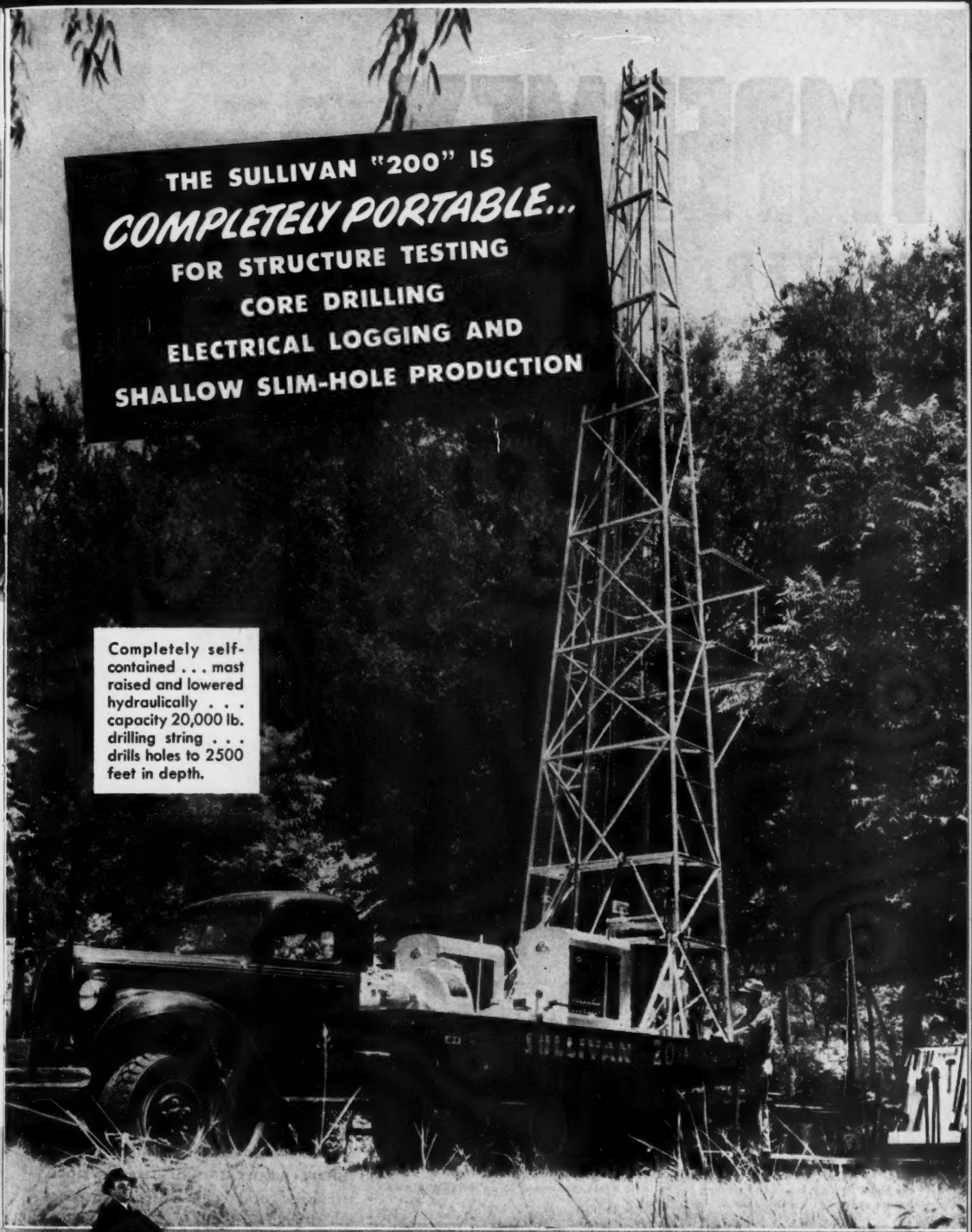
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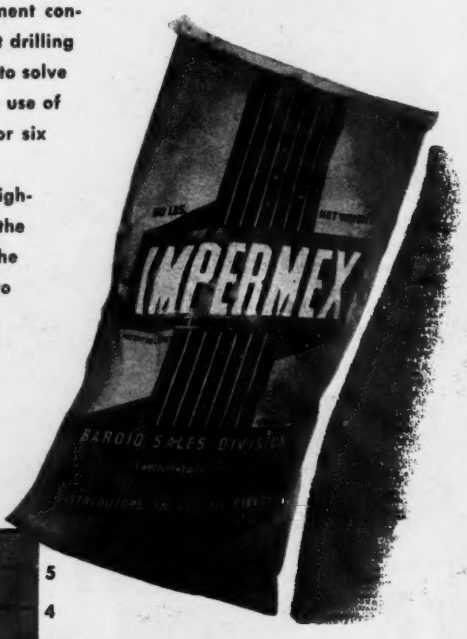

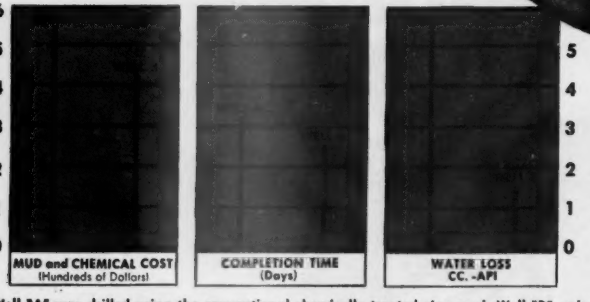

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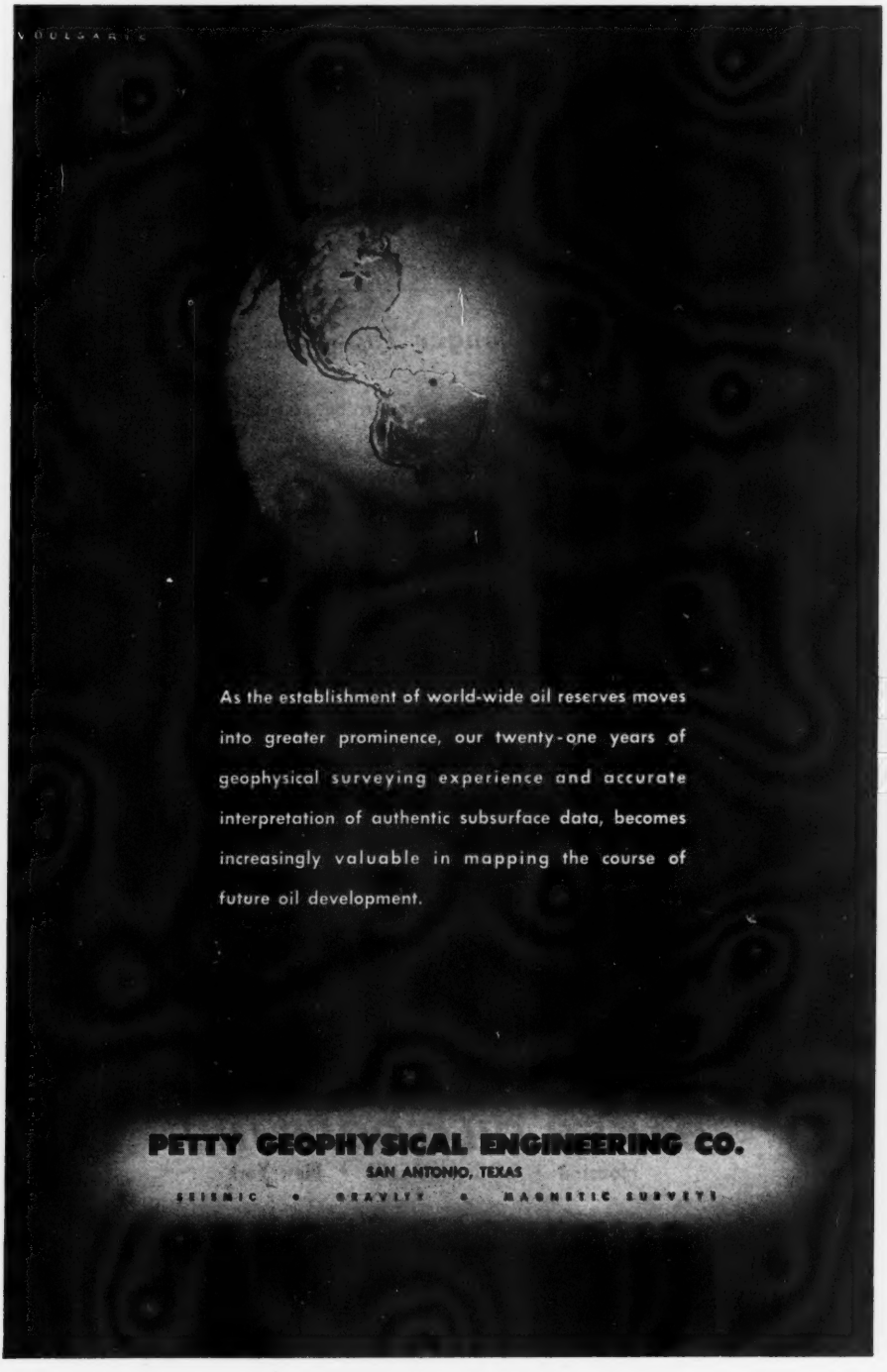
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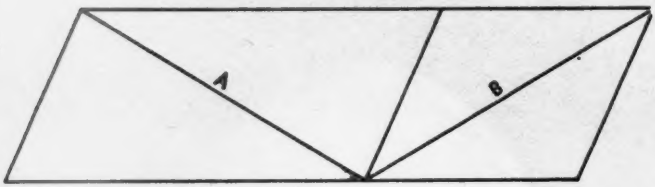

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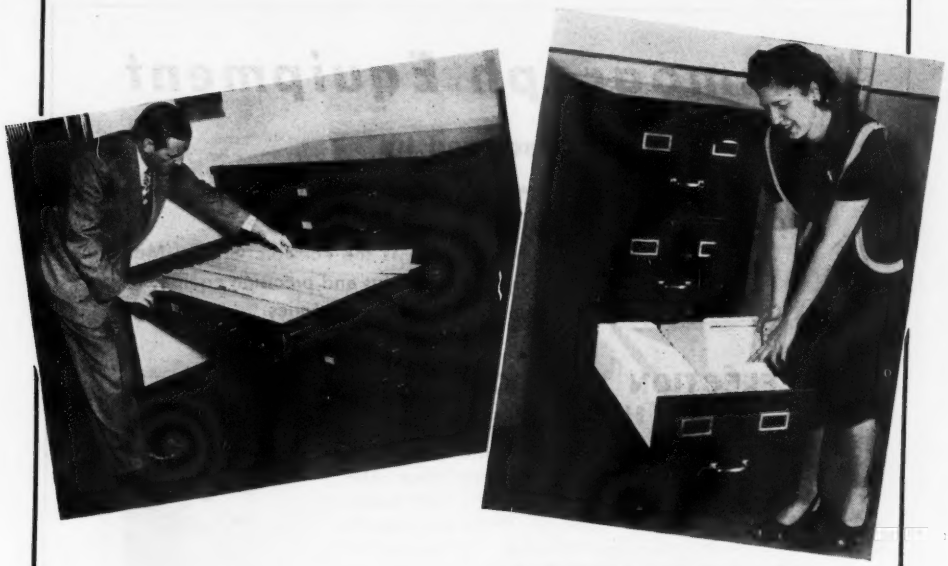

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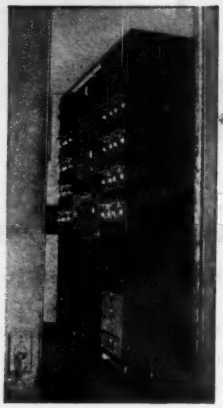

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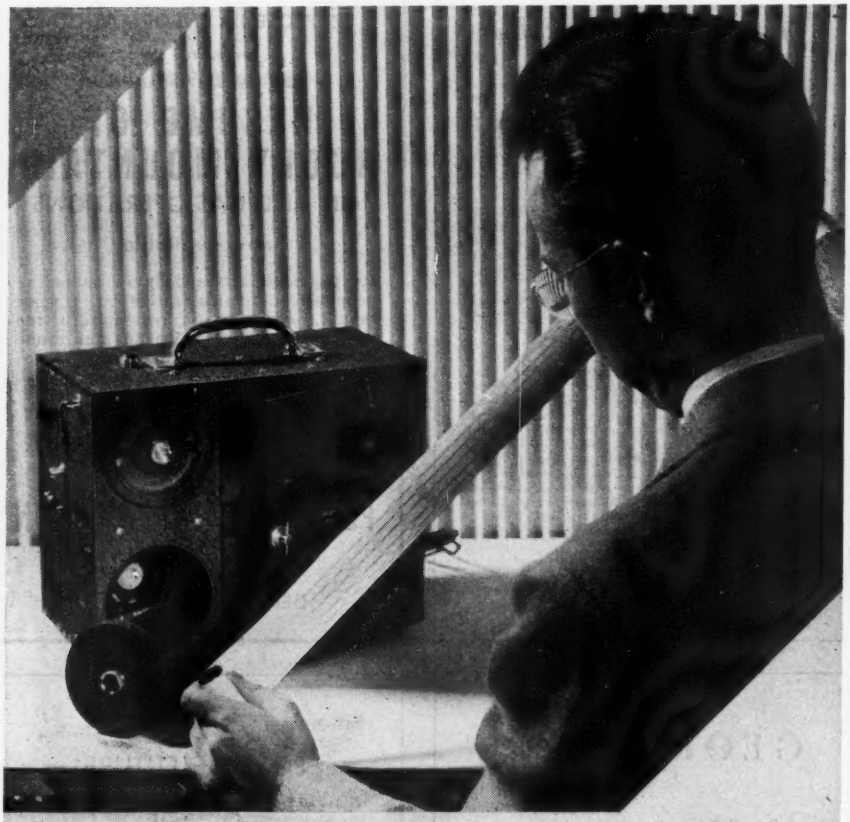

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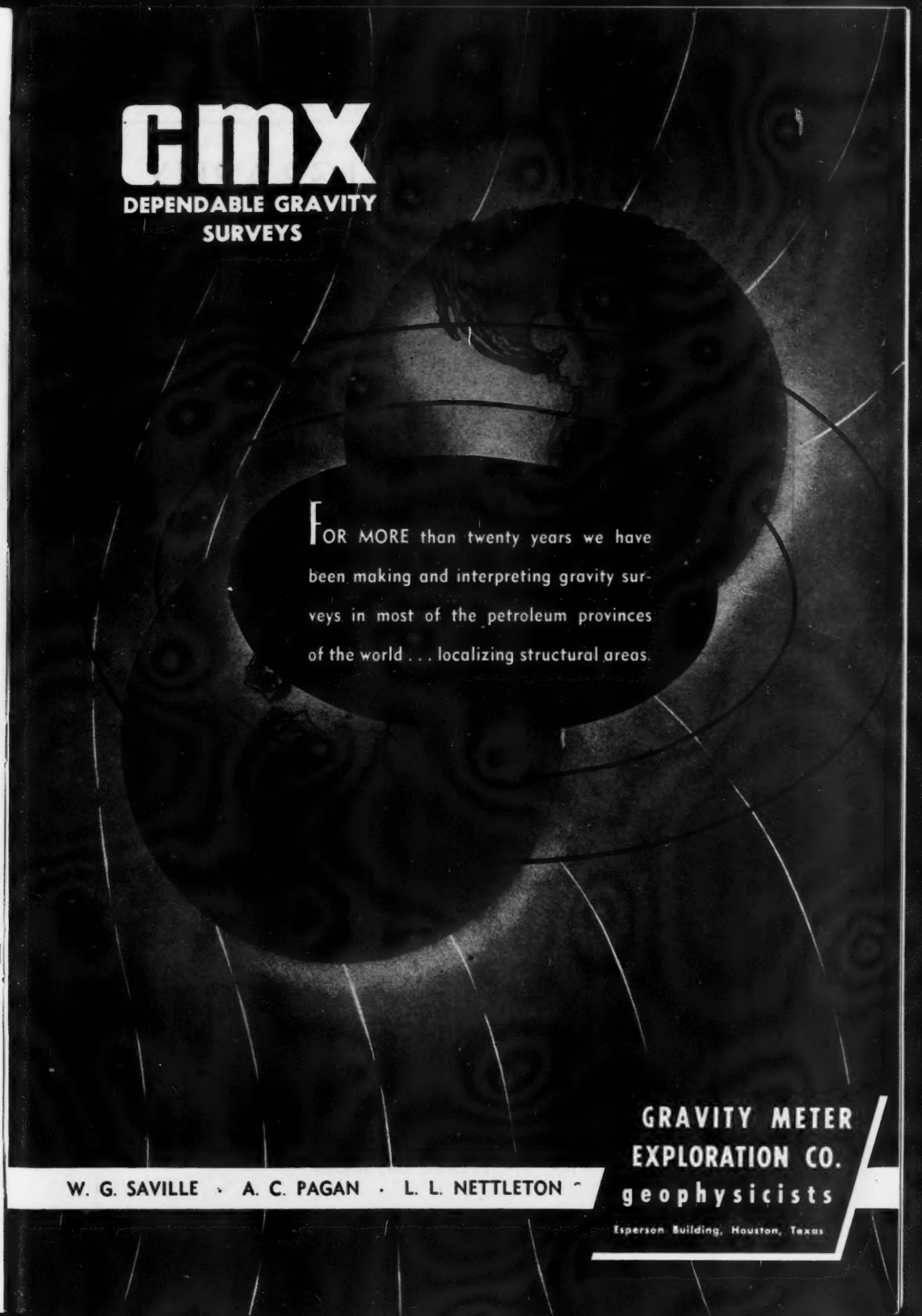
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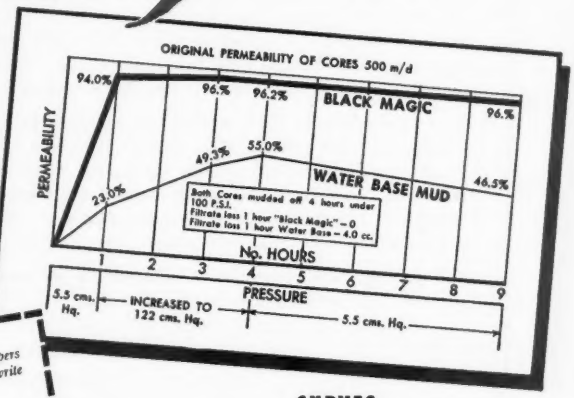

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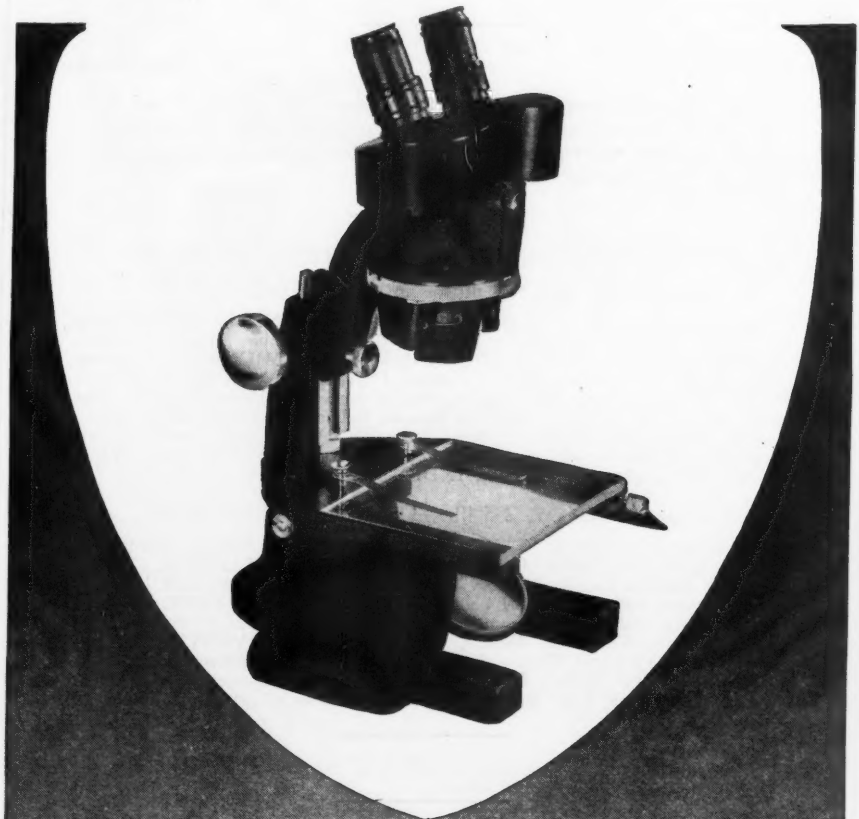

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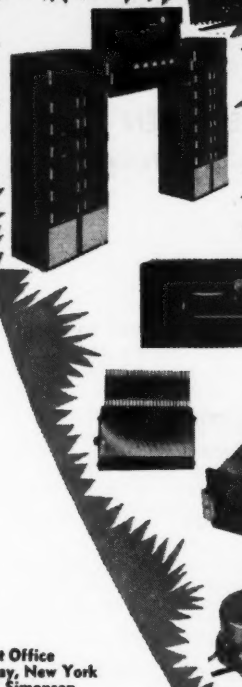

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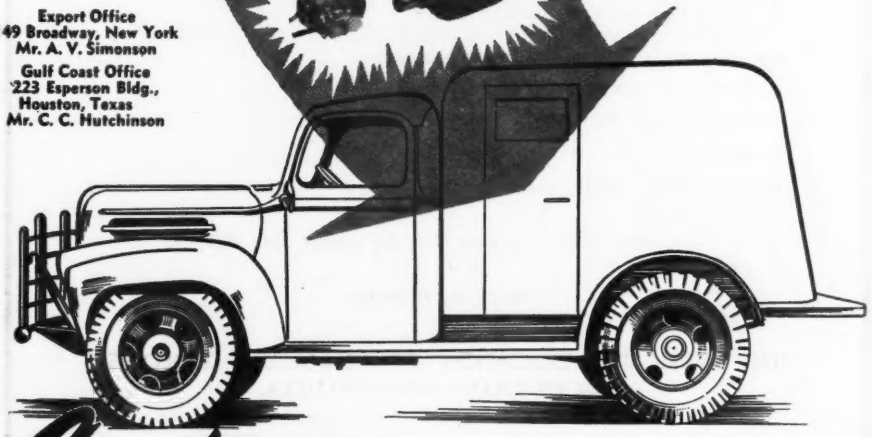

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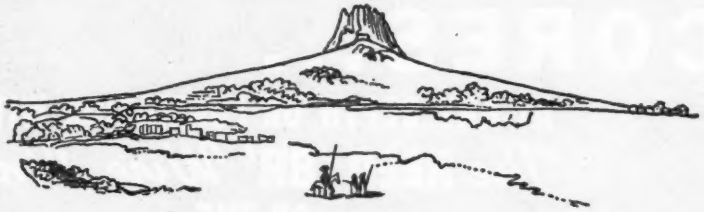

FIG. 20.—Cerro Bernal, volcanic plug. (Reproduction of sketch by Captain G. F. Lyon, 1828; redrawn by F. S. Howell.)

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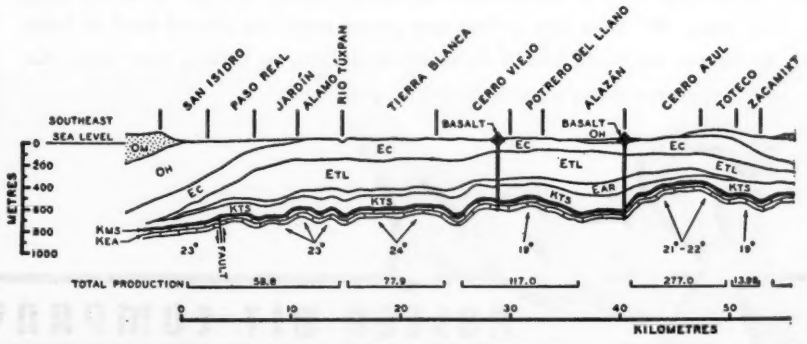

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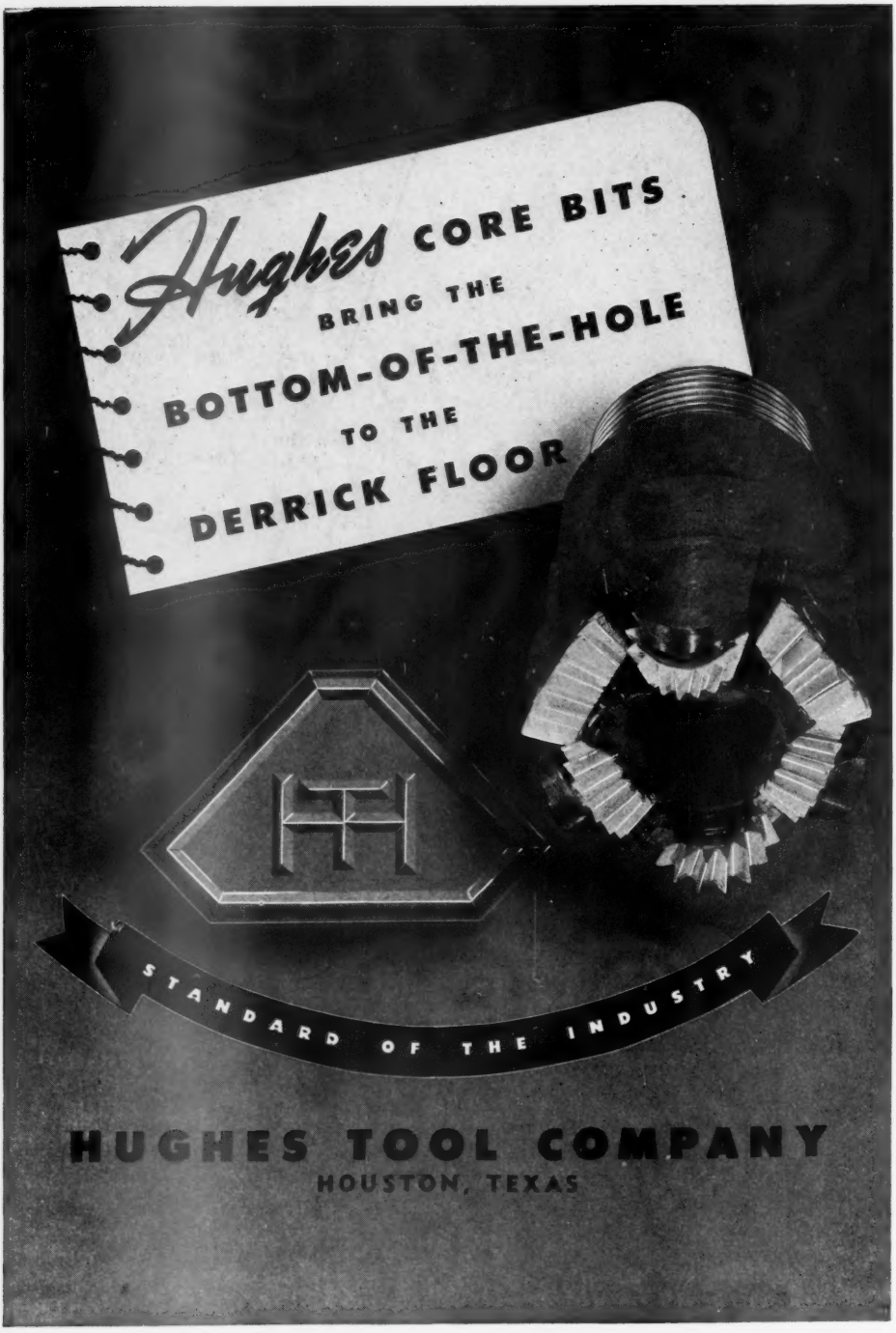
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